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39

CONSTRUCTION IN THE XXI CENTURY: LOCAL AND GLOBAL CHALLENGES

JOINT 2006 CIB W065/W055/W086 INTERNATIONAL SYMPOSIUM PROCEEDINGS

edited by
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(*W065 and W055*) (*W086*) (*Ar. Tec.*)

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Table of Contents

Introduction

This book contains the executive summaries and related papers (in the enclosed CD) that were submitted on the occasion of the Joint International CIB Symposium, *Construction in the XXI century: Local and global challenges*, that was held on 18-20 October 2006 in Rome, Italy. The contributions reflect the call for papers for the annual meeting of three CIB Commissions:

– W055 (*Building Economics*),
– W065 (*Organization and Management of Construction*) and
– W086 (*Building Pathology*).

These three commissions operate under the umbrella of CIB (International Council for Research and Innovation in Building and Construction, formerly Conseil International du Bâtiment). Established in 1953, CIB is based in Rotterdam, the Netherlands, and is the world's foremost organization for construction researchers and practitioners.

The book is divided into two sections. The first contains the contributions to the W065/W055 commissions, while the second pertains to the contributions to the W086. All the contributions are listed in alphabetical order of the last name of the author or first co-author.

In the first section, the content of the papers reflects six broad areas of concern:

i) *Global and local issues of construction*, with emphasis on sustainable design and construction as well as the built and natural environment with consideration of appropriate technologies.
ii) *Changing frontiers of construction*, with particular attention to clients as drivers of change and new frontiers of building design and representation.

iii) *Structure and performance of the construction industry*, with case studies of national construction industries and international comparisons of construction practices.
iv) *Competitive strategies for the XXI century*, with many contributions focusing on new management and industrial theories and applications, criteria for improving the performance of construction firms, including innovation issues, the need for collaboration during design and construction, and critical comments on project delivery systems.
v) *Management of human and physical resources*, with studies of professional development and labor training and skills, cultural aspects of construction, the emerging role of women in the industry, organizational learning, and construction planning techniques.
vi) *Economic aspects of construction*, including macroeconomic issues as related to specific countries, cost estimating issues and risk management for construction projects and firms.

In the second section the content of the papers reflects three main thrusts:
i) *Case studies of building failures*, namely reports containing the building pathologist's analysis of the failure, with varying degrees of complexity, of a building system or component, usually with the intent of identifying responsibilities, proposing remedial solutions or preventive actions.
ii) *Degradation mechanisms, failure modes and durability optimization of building materials and technologies*, that is, the first generalization level of knowledge that a building pathologist can elicit from the analysis of similar failures.
iii) *Pathology-conscious building design and life cycle planning*, a further level of knowledge represented by rules and methods that results from the analysis of case studies and identification of defects and errors.

I would like to thank all the authors of the published contributions for their excellent work and enthusiastic participation in the event. At the moment of this writing, in fact, more than 180 delegates from around the world are expected to attend the symposium.

I am indebted to those colleagues who organized the four workshops that were held during the event. Special thanks belong to the editors, particularly Teresa Tatulli, whose efforts made this publication possible.

Roberto Pietroforte, Ph.D.
Chair of the Editorial Committee

SECTION I

Executive summaries, W055 and W065 Commissions
(*edited by R. Pietroforte*)

A review of the relationship between skills and productivity in construction

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UK government considers 'skills' key driver of productivity across different sectors of the economy. A survey of the existing literature relating to skills and productivity reveals the lack of a clear and specific evidence in construction at the firm level. This is fundamental to demonstrate to employers how a process of skills development could induce productivity gains.

Keywords: skills, productivity, review and policy.

1. Skills as driver to productivity

A fundamental element of the workforce productivity performance is governed by its skills domain meaning that a workforce with lower skill levels represents a constraint for realizing maximum performance potential. Crafts and O'Mahony [1] found that UK productivity lags behind other countries because of a lack of skills. They argued that skills could potentially help in closing the UK productivity gap with other nations. In addition, Clarke and Wall [2] conclude that the construction process in the UK depends on a lower level of skill than in Germany and the Netherlands. More recently, the Pre-Budget Report [3] prescribes skills as a key driver for productivity within the UK economy. Accordingly, it promotes the attainment of higher qualification level and training as a means of developing the workforce skills and realizing such productivity gains.

The aim in this paper is to unpick the knowledge gaps which act as a constraint for applying what is already known, e.g. why employers are not investing enough in developing their workforce skills? But first some of the *barriers* to establishing a relationship between skills and productivity within the context of the construction industry are listed.

2. Barriers to skills and productivity

2.1 Definitional problems
2.2 Totality of factors affecting productivity
2.3 Nature of the construction industry

3. Themes in the literature

3.1 Logistics and late material delivery

Workers are vital parts of the supply chain especially that labour-only-subcontractor make-up a considerable proportion of the workforce in the UK. Thus, having highly skilled workers with an ongoing training and development will help in providing strong links in the supply chain. For example, if a material supplier employs people with poor communication skills (e.g. ICT) and not enough experience, then the chances of having poor performance become apparent which is manifested in late delivery or wrong order of material. This may result in a knock-on effect on-site creating a back log of work and thus a drop in productivity levels, though the best skilled people may be hired on site. However, problems with material logistics may occur due to shortage in global material supplies (e.g. steel), which is out of the hands of the supplier. Therefore, it is important to ensure that the suppliers workforce maintain appropriate level of skills to minimize the effect of problems arising that could be attributed to poor skills. The workforce skills across the supply chain are important for passing on productivity gains on site. Having a reliable supply chain that applies cutting edge logistics system requires equipping the workforce with the necessary skills for doing that.

3.2 Workforce Skills

It is essential to recognize that both managers and operative skills have a role to play in improving productivity.

This would fit with the nature of a construction project, which involves complex inter-relation of different activities. For example, if managers set up sophisticated systems and plans for operations, then it would mean nothing unless there is a willing and skilled workforce who is capable of delivering. Conversely, the best skilled workforce will not be able to work productively without the support of a good management practice, e.g. ensuring that materials arrive on time. It follows that the skills of both operatives and managers, which is manifested in a good work practice, complement each other and this should be reflected in streamlined operations on-site that could result in improved productivity levels. However, management have the authority to give bonuses which may result in motivating the workforce and driving up productivity performance. A demotivated workforce could create time losses as much as 13.6 man-hours/week [4].

3.3 Labour training

With the growth of self-employment in the UK construction, it becomes difficult to ensure that the construction workforce receives the necessary training to make it perform competently and let alone improving productivity. This responsibility falls within the remit of the Construction Industry Training Board (CITB) which has a central role to play in ensuring that the workforce receives enough and adequate training. A progress has been achieved with the Labour Force Survey (LFS) [5] reporting an increase of 68.8% in the participation in training in construction over the last decade. However, it is important to ensure that participation in training is derived from an actual business need. Training could be an extremely expensive way of attempting to remedy a human performance problem if it is not the most appropriate strategy to use [6].

3.4 Education attainment

Sole reliance on qualifications as a measure of skills in the workforce is far from ideal. Many skills are acquired at the workplace and remain uncertified in a formal way, e.g. computer skills. For these reasons, qualifications can only be regarded as a proxy for workforce skills. Simply increasing the supply number of workers with higher levels of qualifications is unlikely to be the full answer to raising the skills that are exercised in British workplaces [12].

This requires matching the required skills demand in the job market with adequately trained workforce, who would be productive at doing their jobs.

So, this vision and understanding should be projected onto the construction industry, because simply if the workforce became more qualified then this would not mean a panacea for the industry problems and boost in its productivity levels.

4. Conclusion

There is no specific and clear evidence to support the claim that skills improve productivity at the firm level within the construction industry. This presents a real barrier for persuading employers to invest in the process of skills development, e.g. through training.

This requires a firm level enquiry that would involve asking employers about productivity benefits derived from investing in their workforce training and development. The evidence of improvements which accrue from such investment would undoubtedly be broader than straight output improvement. This would enable collecting some prima facie evidence of how the two things are connected. Also, the spin off benefits of a better trained workforce could be examined (e.g. improvements in behavior and attitude, interfacing between trades etc - these are known as 'externalities' or external benefits which accrue from the investment in skills). These may actually amount to much more than just the output productivity improvement.

References

[1] Crafts N. and O'Mahony M. (2001) A Perspective on UK Productivity Performance. Fiscal Studies, 22(3), 271-306.

[2] Clarke L. and Wall C. (1996) Skills and the construction process. Housing Research Report 170.

[3] Pre-Budget Report (2005) HM Treasury, London.

[4] Ng S.T., Skitmore R.M., Lam K.C. and Poon A.W.C. (2004) Demotivating factors influencing the productivity of civil engineering projects. International Journal of Project Management, 22(2), 139-146.

[5] ONS (2004) Labour Force Survey, London, The Stationery Office

[6] Buckley R. and Caple J. (1990) The Theory and Practice of Training, 1st Edn. Kogan Page, London.

[7] Felstead A., Gallie D. and Green F. (2002) Work Skills in Britain 1986-2001. University of Warwick: SKOPE.

Establishing project budget growth norms for the roads sub-sector in construction

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Generally, cost overruns are deemed as adverse consequences in the viable delivery of the project. The immediate as well as other stakeholders associated with the project suffer the socio-economic impact of this adverse consequence. To some extent the cost overruns can be deemed as being symptomatic of inadequate planning and budgeting of projects that in turn is a consequence of accuracy of costing data employed for estimating project budgets. Understanding the nature and factors that account for the overruns should assist in establishing more accurate project costs. The aim of the study is to explore the nature and scale of project cost overrun in construction to provide information for planning future projects.

Keywords: construction, projects, budgets, roads, contingency, norms.

1. Introduction

The continued use of contingency in budgeting for construction projects provides an undisclosed acknowledgement of the perennial problem of cost overruns in the delivery of projects. Whilst construction has been happy to encourage the practice of budget uncertainty with the use of contingency, there is evidence to suggest that major clients are demanding more cost certainty [1]. In one sense, the use of contingency can be deemed as the anticipated budget ceiling for any project. In the past the basis for establishing such contingency had been by rule-of-thumb or sometimes rather arbitrary [2]. Davey [3] makes the case that cost overruns often represent symptoms of inadequate planning and budgeting for the projects, which, in turn is a consequence of accuracy of costing data employed for estimating project budgets.

Within this paper, the authors explore the nature of budget overrun and present the interim results from an investigation into the scale of construction project cost overrun.

The study employed project data from road schemes to establish a generic function for the magnitude of cost overrun. The generic function of cost overrun can be employed to provide information for planning future projects on the most likely levels of contingency to incorporate for improved budget certainty.

2. Definition of cost overrun

Generally most actors defined cost overruns on projects as the deviations of actual from estimated cost. In an earlier paper, it was reported that two principal definitions emerge from the literature, the generic definition and the critical activities definition [20].

Within this paper the following definition is adopted: "Cost overrun is the additional cost beyond the planned estimated cost of the project."

3. Modelling cost overrun

The basis of contingency budgets for construction projects is the extent of cost overrun that is expected to occur during the implementation of the project. The investigation involved establishing the scale of such overrun for completed projects in order to provide a generic function original estimates and the outturn budget for the project. Gilchrist [21] and Berk [22] separately support the assertion that mathematical or statistical expressions can be used to establish the behaviour and properties of the quantities being modelled.

The modelling in the study was by regression analysis. Regression analysis is defined by Cook and Weisberg [23] as the analysis "to determine as far as possible with the available data how the conditional distribution of the response Y varies across subpopulations determined by the possible values of the predictor X or predictors Xi."

Simple linear regression analysis statistical modelling technique was adopted because of the number of variables involved and the discrete nature of the data. The generic form of the expression for the modelling is represented as follows:

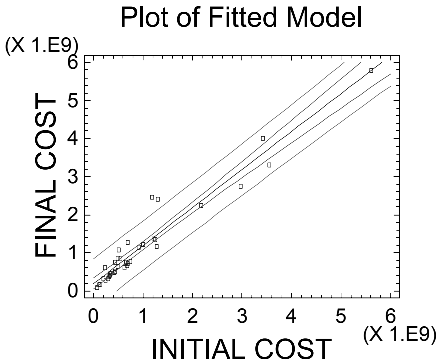
$$Y = \beta 0 + \beta 1X1 + \varepsilon \qquad \text{Eq 1}$$

where β0 and β1, are the model regression coefficients or parameters, and ε is an error factor or random disturbance.

This definition encompass both situations where there is a planned contract schedule identify its critical activities and the other case without such schedule.

4. Results

The plot of fitted model produced from the modelling of the original data is given in Figure 1. This gives a strong indication of a systematic relationship between the initial cost and final cost of the project.



The results of the analysis gave the equation of the fitting linear model that described the relationship between Final Cost and Initial Cost of the original data as follows:

FINAL COST=1.89077E8+0.999149×INITIAL COST Eq 2

This equation relates to the general equation of linear regression which is given by:

Y = a + b*X

Therefore applying this principle to the equation generated from the original data:

Y = Final Cost,

a = 1.89077E8 which is the constant coefficient,

b = 0.999149 which is the slope, and

X = Initial Cost.

5. Conclusion

While cost overrun on construction projects is accepted as a common feature, not much has been done to minimize or eliminate their occurrence and problems associated with cost overruns. The reason was that the true nature and extent of cost overruns was not understood. History can be leant to understand the nature and characteristics to help in deriving a more scientific way of minimizing or eliminating the effects of cost overruns on construction projects. The model in the study would be very useful for obtaining funds for donor funded projects, and for more realistic estimation of project cost. Most donor funded projects are executed on tight budget. Therefore inadequate estimation will result in serious cost overruns on the projects. These effects could be eliminated by the application of the derived model in estimating the expected final cost of projects. The calculated Final Cost therefore becomes the budget for the proposed project. The budget for the project would therefore include the expected cost overruns. Inflation was identified as the only factor that causes cost overruns on construction projects in developed and developing economy differently. Data for the modelling was obtained from developing economy. Therefore the application of the model is limited to projects in the case developing economy. The model could however be modified with data from developed economy to enable an appropriate model, suitable for developed economy to be derived. The model derived from the research would therefore enable project managers and advisers allocate appropriate contingency amounts on construction projects. In this way, cost overruns on construction projects would be eliminated or minimized.

References

[1] McCaffer, R. and Edum-Fotwe, FT (2005) Managing Intangibles – The Latent Dimension for Competitiveness in Construction In: Pantouvakis, JP (ed.) Advancing Engineering, Management and Technology, Proc. of the 3rd Int'l Conf., CITC-III, 15-17 September 2005, Athens.

[2] McCaffer, R. (1976) Contractors' Bidding Behaviour and Tender Price Prediction. PhD thesis, Dept of Civil Engineering, Loughborough University of Technology, UK.

[3] Davey, K. (2000) Preventing project cost escalation, Engineering Management Journal, August, Volume 10, Issue 4, pp. 174-181

[20] Afetornu, C. and Edum-Fotwe, F. T., (2005) Characterising project contingency budget in construction. In: Khosrowshahi, F (Ed.), 21st Annual ARCOM Conference, 7-9 September 2005, SOAS, Univ. of London. Assoc. of Researchers in Construction Management, Vol. 1, pp. 259-68.

[21] Gilchrist, W., (1984), Statistical Modelling. John Wiley & Sons, Chichester.

[22] Berk, R.A., (2004), Regression Analysis, a Constructive Critique. Sages, London.

[23] Cook, D.R., and Weisberg, S., (1999), Applied Regression Including Computing and Graphics. J. Wiley & Sons, New York.

Identification of factors that stimulate or inhibit the adoption of quality systems in construction companies

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The construction industry in Mexico is adopting quality systems in a very low proportion compared with other industries. The decision-makers in the construction companies knows that quality systems are beneficial for their companies, nevertheless, very few of them are implanting a quality system. Many authors have expressed in their works that there are different factors that affect the decision of adopting or not a quality system, this study is focused on identifying the factors that are influencing such decisions in the local construction industry and in which measure they are present. This research is carried out through interviews to the decision-makers and is intended to serve as a starting point to develop strategies in the academy, government and the industry to stimulate the adoption of quality systems.

Keywords: Quality Systems, Quality Inhibitor, Quality Stimulator

1. Introduction

It is perceived that quality of products and services into construction industry is growing up and reaching higher levels than ever. Processes supported by the techniques of quality improvement (such as TQM, re-engineering, among others), which have been successfully proved in the manufacturing industry, are now being used in the construction industry, making emphasis on the process as the key to achieve the highest quality in the products, services and the satisfaction of all of the parties involved in a construction project [1]. In the construction context, quality can be defined as the satisfaction of the requirements of designers, constructor, government, society, and the owner [2]. This satisfaction is being achieved with the support of quality systems, which help to the clients, constructors and designers to achieve the project objectives. There are different approaches such as the one being used by the governments of Singapore, Sweden and Hong Kong, among others, where the governments have a mandatory policy of requiring the constructors to be certified under the ISO 9000 [3]. We have another example in the Housing Development Board, in Singapore, where the use of Six Sigma allowed an improvement of the interiors finish work, in housing projects [4]. In Mexico we still have a long road to walk to achieve the standards mentioned above. In spite of the existing need of better services and products with a higher quality, we can perceive an interest in the constructor on being part of this culture. The signs of a low interest on consumers satisfaction in construction projects is evident in the local newspapers: From January till June of 2004, the Mexican Federal Agency of Consumer (PROFECO), had reported claims against the services provided by construction companies, totalizing 5,190 for an amount of 20.6 million dollars. The main claim topics includes, delay in the termination of the project, uncorrected construction errors, performance failures, violation of the contract, among others [5].

Facing this situation, what should we do? Why, if the quality systems are so good for the industry, the decision makers are not opting to invest in a quality system for their companies? Which are the keys to achieve a substantial participation of the construction industry in this quality culture?

This research is focused on identifying what factors have a strong influence, in a positive or negative way, on deciding to adopt a quality system in a construction company in the State of Yucatan, Mexico.

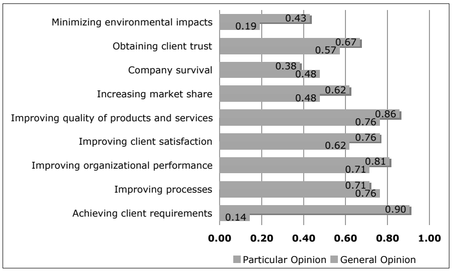
2. Methodology

We took as a universe for this study, the official list of companies registered as actives in the local chambers of construction. 48 construction companies compose the universe. The study unit is the decision-maker with the faculty of deciding on investing in the implantation of a quality system in a construction company. The calculated sample size is 40 for a standard error of 0.02. We propose the use of the Influence Index (I), for measuring the influence level of the stimulator or the inhibitor. This is calculated as the proportion of the times that an item was considered as a "definitively it influences" from the total of interviews.

3. Survey results

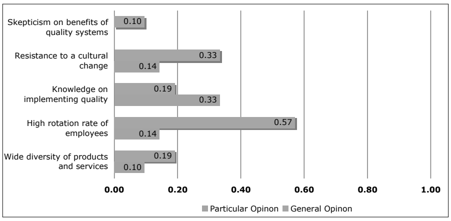
The general section of the questionnaire is intended to identify the general attitude of the decision-maker on the decision of adopting a quality system for non a particular company, so the attitude shown will depend on the knowledge, academic formation and the professional experience of the decision-maker.

Figure 1. Influence index of stimulators



The particular section identifies the attitude of the decision-maker on adopting a quality system for the company where the decision-maker is currently working. In this section can be identified, what are the strengths and weaknesses of the companies in order to implant a quality system.

Figure 2. Influence index of inhibitors.



4. Conclusions and discussion

The geographic region surveyed, show a high level of motivation to adopt quality systems; originated by the knowledge and experience of the decision-makers. In contrast there is a poor consumer culture that inhibits the demand of high quality standards; resulting in a very poor stimulator: "Achieving client requirements" which in occasions have a behavior most like an inhibitor.

From the point of view of inhibitors, the context shows a lack of experience in implementing quality systems and a low level of knowledge on quality issues; this results in emerging a doubt about the capacity to achieve a successful implementation. Additionally the lack of resources to invest in the implementation of a quality system makes the doubt stronger and finalizing in pushing the decision to the side of not adopting a quality system.

There is a need of educational programs that allow the community to enter in a consumer culture; that create a conscious state on the demanding of high quality standards; and prepare clients to evaluate construction projects based not only in the cheapest approach, because this not always is translated into savings.

References

[1] Arditi D. and Gunaydin H. (1999) Perceptions of Process Quality in Building Projects. Journal of Management in Engineering, (USA).

[2] Arditi D. and Gunaydin H. (1997) Total Quality Management in the Construction Process," International Journal of Project Management, (USA).

[3] Low S. and Lim R. (2000) Quality System QS 9000 for construction: is the industry in Singapore ready?, Journal of Construction Research, (Hong Kong).

[4] Sui L. and Sze M. (2004) Applying Six Sigma in Construction. Journal of Construction Engineering and Management, (USA).

[7] Lopez M. (2004) Niegan Amparos Contra PROFECO. Reforma Newspaper, Edition of July 28, (Mexico)

A service based framework enabling collaborative construction project management

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This paper highlight the importance of formalizing construction process components in a single context in order to enable a consistent management of the engineering activities. A framework for a collaborative model in construction project management is presented incorporating the service based technology as the conceptual foundation. Within the framework, project tasks become more applicable and more comprehendible even for distributed engineering virtual teams on a network.

Keywords: Construction Project Management, Collaborative and distributed engineering system, Building process models, Web Services.

1. Introduction

Large and/or complex projects are tackled by a number of individuals and organizations who collaborate and work jointly on the construction project from its inception to completion. Furthermore, the planning processes in complex civil and building engineering projects are carried out by a lot of different engineers working collaboratively in projects teams whose members often reside in different cities or even different countries. Recent improvements in ICT accelerate this collaboration while emerging technologies such as Web Services (WS) [1] have enabled new applications consisting in a set of services to be invoked by users. .

Assuming the WS Architecture as enacting paradigm, this paper presents a framework that is concerned with the collaborative engineering in construction project management.

2. The service based framework

The proposed framework is based on the acceptance that collaborative construction project management is a human-based, interdisciplinary and socio-technical activity and can be modelled as a set of processes accordingly [2] [3]. A construction project is assumed as composed by a set of functional processes that a group of humans may go through on a network of computers (e-nodes) interacting with one another in order to offer or to ask for services. Similar to an e-market-space, this collaborative engineering environment (CEE) is a virtual cooperative environment where the physical distribution of resources and access problems are masked via the service interface. Each service is offered by an e-node, namely a pool, that sets the rules under which the service can be accessed by other e-nodes through service invocation.

A pool is most often assumed to mask an individual human that possesses a body of knowledge and values that are applied to decisions or contribution made to a collaborative engineering process. A pool may, however, mask an organization i.e. a community of individual humans that collectively have an agenda or purpose that they are pursuing. Pools need to be taught on how to set-up a CCE that operates through the network and allows complex tasks requiring the collaboration of various services spread over different pools each of ones is described by a set of local information sources and a set of local services.

As shown in Figure 1, the framework has a layered architecture consisting in four level of abstraction and expresses an appropriate modelling of collaborative processes that can be decomposed and made executable as granular services individually.

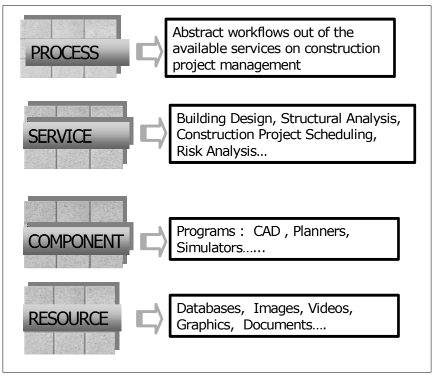

Figure 1 . The proposed Service Base Framework

Specifically, at process layer, this decomposition is formalized by a abstract workflows out of the available services on construction project management . Each workflow expresses a sequence of cooperative tasks each performed by a set of e-services and is designed by the project manager that is in charge of coaching pools partners through the entire process life-cycle. A workflow includes points of access to remote information sources and points of cooperation with other e-nodes' workflows as well as possible destinations of processed information. The services layer models granular processes performed by an e-node or other local control activities. The services organize their activity on the basis of both local and network information sources and are related to the particular project context by the workflow describing the services to be executed and the context knowledge applied to solve a problem, to enact a decision or to achieve a goal. The component layer expresses software components invoked at services layer. Finally, the resource layer collects electronic resources related to the activities assigned to each e-node Information within a workflow is organised in purpose-centric aggregations of resources referred as views. Each collaborative team has one or more views under which he participates and contributes to the CEE . Specifically, a view of an individual user may be considered a local resource and collection of views of a collaborative team may be considered a shared resource. These distinctions are important because construction project management originates in the view(s) of individual users and is reinforced through the acceptance and integration into a collection of views of a collaborative team. The framework models how construction process management is carried out by a number of services where the physical distribution of resources and access problems are masked via the service interface while a workflow ensures that appropriate collaboration. As new information sources and processing techniques become available, they are simply represented as new services thus ensuring the environment scalability.

3. The web service technology

WS are distributed services which consist of independent application components published on the Web in a way that they can be used by other Web applications. A register (UDDI) maintains detailed lists of published Web services and acts as a bridge between service providers and service requesters. The WS architecture make it possible to implement a distributed integration infrastructure where an active mediator acts as information broker between the client devices and the information sources so allowing each client to share and update information.

4. An application scenario

To explain how a collaborative process can be formalized the paper considers a construction project management where the PM models the planned work process by a traditional CPM diagram and project personnel who are responsible for the activities . This process can be supported by many proprietary software application whose interoperability is still an issue. However, information sharing is a mandatory requisite when the project management involves several other parties (i.e. teams of specialists in different areas) each of ones may use specific applications that reside on distributed and networked computers. According to the proposed framework, the integration process can be modeled, at process level, by a workflow that expresses the project scheduling as a single service composed by a set of web services, each offered by a single team. Specifically, the service level exposes software applications that are available within the different teams. At component level, the proprietary software components are wrapped as WS in order to export their functionality. Finally, the resource level models basic information such as graphics, spread sheets, diagrams etc.. In short, the presented framework and the WS architecture make it possible to implement a distributed integration infrastructure allowing each team to view and update the project on a Web browser.

5. Conclusions

The proposed framework is an effort that tries to give some answers to collaborative engineering challenges by offering a service based environment that is needed as a backbone for the cooperation. The adoption of a service based architecture offers the possibility to share information and use value added community solutions that facilitate the construction project management.

References

[1] Booth, D., Haas, H, et al. (2004), Web Services Architecture. *W3C Working Group note 11,http ://www.w3.org/TR/2004/NOTE-ws-arch-20040211/.*

[2] Cutkosky, M, Engelmore, R, Fikes, R, (1993), PACT: An experiment in Integrating Concurrent Engineering Systems*, IEEE Computer, Special Issue on Computer Supported Concurrent Engineering, 26(1):28-37,*

[3] Bosin, A., Dessì, N., Fugini,M.G., Liberati, D. and Pes,B.(2005),Applying Enterprise Models to Design Cooperative Scientific Environments. *Workshop on Enterprise and Networked Enterprises Springer, LNCS 3812/2006: 281-292* .

Risk management practices of construction project staff: Preliminary lessons

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The management of risk in construction is influenced by the knowledge and attitudes of project staff who, are required to deploy the techniques and tools as part of procedures within a project. The investigation provided evidence to suggest that risk management usage in the execution and planning stages of the project life cycle is higher than in the conceptual and termination phases. Equally, experience, personal judgment and brainstorming are the tools mainly used in risk management. Risk management packages, and formal risk management techniques are rarely used due to lack of familiarity with tools, resource constraints and management culture of organizations.

Keywords: risk, risk management, project, analysis, judgement.

1. Introduction

From a construction perspective, risk is the occurrence of an event that has consequences for, or impacts on, outcome of the delivered project [1]. As such, each construction risk can be considered as reflecting one or more of three types, namely, known risk, known unknowns and unknown unknowns, [2]. The management of these categories of risks often rely on procedures and processes that are aimed at facilitating the identification, and/or optimisation of the contribution from different risk factors towards a mitigation decision. There are conventional methods for applying the procedures and processes involved in managing risks. The practice of these procedures within construction however, differ from company to company, and similarly from project to project. Chapman, [3] opines that there are variations to the standard project management process that different organisations adopt for managing risk to suit their organisational context. There are numerous tools and techniques available to support the various phases of the risk management process. Their use is influenced by the knowledge and attitudes of project staff who, are required to deploy these techniques and tools. Within this paper, the authors present an investigation that was conducted to evaluate the risk management practices of project staffs in risk identification, risk analysis and risk response in their use of the tools and techniques that are available for managing different categories of risks.

2. Construction and risk

The notion that risk management should be an integral part of the management considerations for the execution of construction projects is well and widely shared by the leading project management institutions and professionals [4] [5]. The scope of attention given to risk and the extent of detail that is reflected by any analysis however, varies considerably. BS 6079, [6] regards risk as the uncertainty inherent in plans and the possibility of something happening that can affect the prospects of achieving business or project goal. The management of risks therefore, is essential for effective and efficient delivery of every project and organisation within construction. Boehm, [7] suggested a process consisting of two main phases, Fairley, [8] proposed about seven steps, and Chapman and Ward, [9] outline a generic PRM process consisting of nine phases.

3. Risk management practices

According to Webb, [10] formalised risk analysis and management is a relatively recent development within construction but risky projects have been successfully completed in the past without a formalised approach, so an effective informal process must have existed. Formalised risk analysis and management, however, removes the element of chance associated with an informal arrangement. The management of risk often involves the deployment of tools to arrive at a systematic consensus. Techniques of risk analysis in construction projects include risk premium, risk adjusted discount rate, subjective probability, decision analysis, sensitivity analysis, Monte Carlo simulation, stochastic dominance and intuition.

4. Survey

The elicitation instrument comprised five sections. The first section addressed background information, and explored respondent details of highest academic qualification, years of experience, current designation, and role in organisation. The second section explored the risk-related decisions the respondent makes, the frequency and the background information required to make such decisions. The third section dealt with the risk strategy of the respondents' organisation in terms of formal risk management procedures, and the risk management team. It also enquired into the key stages of the project at which these risk management procedures are applied. The fourth section looked for details of the extent to which the respondent knew various tools proposed for managing risk as well as their preferences for managing risks. The final section focused on the benefits of risk management and factors that influence the implementation of risk management tools and techniques. This paper addresses in detail sections two, three and four. The survey was administered by post and complemented by email to a sample of 65 staffs randomly selected who were involved in various projects within UK construction industry.

The survey achieved a response rate of 40% from respondents drawn from contractors and project management practices across the UK. The contractors included both national and regional companies. The respondent group reflected that many staff play a variety of roles in their organisation and account for any risks related to any work section which they make decisions on.

Overall, 80% of the respondents indicated that their roles involved accounting for any risks related to a work section or whole project in which they made decisions for. The decisions are made in accordance with laid down procedures. All respondent have formal risk management procedures which enables the systematic management of risk.

Under the section risk awareness and tools, 14 tools and practices mentioned in literature as contributing to project risk management were listed. In the first part respondents were asked to indicate the extent to which they knew these tools and practices. From the responses shown in Figure 2, it is evident that formal risk management techniques are still rarely used in the construction industry, and as such most construction project staffs are not familiar with these techniques. Experience, personal judgement, checklist and brainstorming still top the list of tools familiar to project staff. Figure 2 shows that most of the respondents are only familiar with only probability-impact scores (40%). This is followed by Monte Carlo simulation (32%), decision tree (28%) and sensitivity analysis (26%). Almost all project staff depends on experience, personal judgement and intuition to manage risks involved in construction. This is followed by probability-impact scores (40 %). The popularity of probability-impact scores compared with any other formal techniques of project risk analysis and management is probably because; it permits ranking of risks.

5. Conclusion

Project staffs rely predominantly on experience, personal judgment and brainstorming as the principal tools for their risk management. Risk management packages, and formal risk management techniques are rarely used due to lack of familiarity with tools, resource constraints and management culture of organisations. Whilst it appears obvious to explore mitigation at the earliest possible decision in the project lifecycle, it would appear that considerable effort is put into managing the risk at the construction and post construction stages rather than the more strategic stages of the project proposal. The evidence from the study suggests that risk management usage in the execution and planning stages of the project life cycle is higher than in the conceptual or termination phases.

References

[1] Flanagan, R and Norman, G. (1993) Risk Management and Construction, Blackwell, Oxford.

[2] Smith, N. J. (2003) Appraisal, Risk and Uncertainty. Thomas Telford, London

[3] Chapman, C. and Ward, S. (2002) Managing Project Risk and Uncertainty. Wiley, Chichester.

[4] Dixon, M. ed. (2000) Association of Project Management: Body of Knowledge, P&E 2000 Ltd, Peterborough.

[5] PMI (2004) A Guide to Project Management Body of Knowledge - PMBOK Guide, PMI, PA.

[6] BSI (1996) BS 6079: Guide to Project Management. BSI, Milton Keynes.

[7] Boehm, B.W. (1991) Software risk management: principles & practices. IEEE Software, 8, pp. 32- 41.

[8] Fairley, R. (1994) Risk Management for Software Projects. IEEE Software, pp. 57 - 67.

[9] Chapman C, and Ward S. (2003) Project Risk Management: Processes, Techniques and Insights. J. Wiley & Sons, Chichester

[10] Webb A. (2003) The Project Manager's Guide to Handling Risk. Gower, Hants.

Incentive mechanisms in construction contracts: Interviews with clients and contractors

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Partnering guidelines often recommend that economic incentive systems are brought in to create a win-win atmosphere and elicit constructive collaboration. However, there are only a few empirical studies of how economic incentives are implemented, and these highlight inconsistencies in how these are designed and managed in practice. This paper reports the results of an interview study comprising 7 clients and 7 contractors, focusing their views on and experiences of incentive arrangements in general, not only in partnering projects. Incentives were estimated to be used in about 10% of the projects, most when demand is high, and concerns to share and minimize risks were often mentioned. Incentive arrangements were perceived to require trust and can also reinforce trust, but may become the subject of fixed pie negotiations about target cost adjustments.

Keywords: incentives, gainshare-painshare, collaboration, motivation

1. Introduction

There is a trend to abandon traditional construction contracts in favour of more collaborative arrangements. The need to improve motivation in a traditionally conflict prone context has been an important driver for introducing incentives that align the business goals of the individual participants with project objectives [1], and partnering guidelines often view economic incentive mechanisms as essential to elicit constructive collaboration and innovation.

Still, there are few empirical studies of how such arrangements are negotiated and implemented in projects. This study investigates the use of economic incentives, mainly gainshare-painshare models, in Swedish construction. The aim is to gain a general understanding of what kinds of factors that prompt the use of incentives in a construction context, what processes might be affected and how they are related to collaboration.

2. Incentive areas and risks

A variety of aspects and outcomes may be "incentivised", i e rewarded by incentives. Most authors mention cost, schedule, quality and safety as the main incentive areas. Regarding incentives specifically relating to cost performance, it is common to use a target cost approach [2]; [3]. Here, there is a direct relationship between cost performance and contractor rewards, so that gains and losses in relation to an agreed target cost are divided between the client and the contractor. However, cost incentive contracts are not without problems. A focus on performance in areas that are measured and explicitly rewarded may crowd out intrinsic motivation [4], why economic rewards may fail to elicit an open-ended, benevolent and co-operative state of mind.

3. Previous studies

Arditi and Yasamis [5] found that the parties were generally ill informed of the basis and contents of the incentive arrangement. Further, most contractors received schedule incentive payments near the maximum limit, while penalties (disincentives) were rarely issued. Similarly, a study of US government [3] identified a clear tendency that owners pay incentives also for average performance, and in cases when performance targets were not met.

Bresnen and Marshall [6] studied six partnering projects with economic incentives and pointed at a number of inconsistencies in the design and implementation of the incentive schemes. One conclusion was that the collaboration and commitment observed in the cases should be attributed not to immediate economic incentives, but to the prospect of future work, or to more psychological and social rewards such as greater autonomy and improved working relationships.

Thus, previous studies have pointed at a lack of knowledge of how incentives are designed and managed on a more detailed level, as well as of the more precise relation to collaboration and innovation.

4. Methodology

This paper reports the results of the first phase of a larger study of incentive mechanisms and inter-firm collaboration in construction projects. Semi-structured interviews have been carried out with seven clients and seven contractors.

The interviews were designed to provide a broad overview of what kind of incentives are used in Swedish construction, in what situation and for what reason. Further, respondents were asked about their experiences of incentive contracts and their general opinions of success factors and risks. The focus was on economic incentives, in particular target cost arrangements. The wider purpose was to serve as a basis for designing deeper case studies of incentive contracts in a practice context.

5. Interview results

The respondents perceived target cost arrangements as the most common incentive, and contractors estimated them to be used in about 10% of all construction projects. High level of uncertainty, large and complex projects and high demand were associated with use of incentives. Two contractors, however, believed that incentives could be used in all projects provided that there was some room for contractor creativity. The main reason to use incentives was “to keep costs down”, but also to induce innovative behaviour and collaboration. Incentives allowed clients to buy knowledge and competence. Symbolic effects of incentives as a way of starting a dialogue and work with open books were also mentioned.

Concerning how gains and losses in relation to the agreed target cost should be shared between the client and the contractor, clients tended to have strong, but differing, views. Contractors had less strong opinions. They emphasised that deciding about sharing fractions was a part of an initial negotiation process, and that these vary widely between projects.

Among perceived key success factors, contractor commitment and responsibility were seen as important, while clients should show commitment, competence and generosity. Both contractors and clients said that some clients find it hard to accept that the contractor makes a profit if savings are made. On the other hand, contractors have a considerable advantage in setting target costs, and one view was that there had to be limits to how much a contractor could earn.

The importance of trust was strongly emphasised by all interviewees, and incentive contracts were only used when there was a basic level of trust between the parties. The most important threat to trust was negotiations about target cost changes due to changes in client requirements or new circumstances. Both parties have opportunities to pursue opportunistic strategies, and project managers try to establish rules to guide target cost adjustments. These rules, however, vary widely. In one case, the target cost might be changed frequently, while other respondents said that the whole point of incentive contracts was that only additions in building area or important changes in the functions (from office to laboratory) should result in target cost changes.

6. Conclusions

Negotiations about target cost adjustments versus incentive outcomes present important challenges to the relationship, and thus are key relationship indicators. Case studies should focus on these negotiations: What kind of changes lead to target cost adjustments and when is there gain- or painsharing? How frequent are these discussions? What is the relationship to the quality of collaboration and levels of trust? What emphasis is put on stimulating intrinsic motivation, such as communication, teambuilding efforts, client commitment, and opportunities for on creative interaction? To what extent are incentives important as signals of commitment to collaboration or is the emphasis on actual and direct economic rewards? We suggest 3-4 deep and carefully chosen case studies of projects with different kinds of incentive arrangements and client objectives.

References

[1] Bower, D., Ashby, G., Gerald, K. and Smyk, W. (2002) Incentive Mechanisms for Project Success. *Journal of Management in Engineering*, 18, 37-44.

[2] Broome, J. and Perry, J. (2002). How practioners share fractions in target cost contracts. International *Journal of Project Management*, 20, 59-66.

[3] GAO (2005) Defense Acquisitions: DOD has Paid Billions in Awards and Incentive Fees Regardless of Acquisition Outcomes. United States Government Accountability Office. Available from: < http://www.gao.gov/new.items/d0666.pdf> [Accessed 27 April 2006].

[4] Frey, B.S. and Oberholzer-Gee, F. (1997) The cost of price incentives: an empirical analysis of motivation crowding-out. *American Economic Review*, 87 (4), 746-755.

[5] Arditi, D. and Yasamis, F. (1998) Incentive/ disincentive contracts: perceptions of owners and contractors. *Journal of Construction Engineering and Management*, 24 (5), 361-373.

[6] Bresnen, M. and Marshall, N. (1999) Motivation, commitment and the use of incentives in partnerships and alliances. *Construction Management and Economics*, 18, 587-598.

Modelling processes in case studies using rich picture diagrams: A novel approach

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The briefing process for the arts projects has to translate the spatial needs of the so-called 'artistic vision' into a building to accommodate the needs of the arts clients that may be unique and dynamically changing over time. Aiming to elucidate the most appropriate briefing process or processes that deliver a 'better' environment for the arts, an investigation has been set out using multiple cases within the grounded theory methodology. Whilst the writing of the case studies storylines has been considered eminent for the grounded theory methodology, particularly for the cross-case analysis purpose, the complexity and the richness of the information of the case studies was found to be overwhelming and impractical for research team discussions. In attempt to represent the complexity and richness of the information in describing the storyline of the case studies, an approach using rich picture diagrams has been applied in this research and is presented. The reasoning underpinned the development of the diagram to model the case studies is explained and the application of such a diagram in representing the case studies is discussed with the pilot case as an example.

Keywords: arts projects**,** case studies, diagram, grounded theory, rich picture.

1. The research project

The research project aims to investigate the most appropriate practices to enable a 'better' environment in order to deliver excellent buildings for the performing arts. The measurable objective of the research is to investigate and analyse thoroughly the selected buildings for the performing arts which have been briefed, designed and procured in the relatively recent past to identify and develop the successful 'good practice' exploiting the particular skills and abilities in the arts for creating and communicating ideas and 'visions'. The selected strategy is the grounded theory methodology with multiple case studies to ensure an in-depth interaction between the researchers and the participants of the construction process. Two techniques of data collection are applied in this research, namely the semi-structured interviews and the archival study.

1.1. The case studies analysis

The interview transcripts were analysed using NViVo package [1]. In accordance with the grounded theory methodology, analysis of the transcripts was followed by the development of the storyline of each case study to enable incremental cross-case analysis of the case studies. The original format intended for the storyline was by text However, the richness of the information gathered through the interviews was found very complex and impractical to be represented in text format particularly as an object for discussion during the research team meetings and difficult to visualise. There was a need for a different format of representation that capable of modelling the case studies storylines in a macro-view level and demonstrate the relationship between various elements across the timeline.

2. Presenting the case studies storylines

Considering the requirement of the representation format needed for this research, an attention was drawn into the diagrammatic format. Pictorial flowcharts have been prescribed for use where the subject matter is complex, potential to enable more accurate and quick interpretation compared to words [2] whilst the current trend in presenting technical information has been perceived as heading in the direction of more visual methods [3]. In the further attempt to search for an appropriate case studies representation, another research has reported successful adoption of the "rich picture" from the earlier phases of the soft system methodology (SSM) for analysing complex problems. By providing a macro view of the problem, the rich picture was argued to improve the understanding and speed of comprehension by portraying the complexity of a problem and the entwined issues involved [4]. It was then decided to adapt the rich picture approach to diagrammatically represent the case studies storylines.

3. Development of the rich picture diagram

No single best way can be prescribed to produce a rich picture as even the same researcher may use different styles under different circumstances [5]. However, consistency was considered important in the development of the rich picture diagram for each case study, particularly for the cross-case analysis purpose. It was also found necessary to arrange the rich picture diagram in a timeline (according to construction phases) to show the inter-relations among different elements from different phases. The earlier developed budget history diagram [1] was found useful during the development of the rich picture diagram, particularly in tracking various elements and maps them into the appropriate timeline. For illustrating purposes in this paper, the rich picture diagram developed for the pilot case study is presented.

3.1. The major themes and timeline

The rich picture diagram is divided into rows representing the major themes recurring in the storyline. The rich picture diagram for the pilot case was divided into four rows, namely the Market and external condition, the Funding and financial, the Vision for theatre, and the Distinctive features. Other case studies may have different numbers of recurring major themes and/or different major themes. The timeline is divided into different phases in accordance with the budget history diagram of the pilot case (project phases).

3.2. The pictorial representation

For consistency, various pictorial representation are standardised in this research project. The pictorial representations used in the rich picture diagram can be considered self explanatory completed with some textual explanations. The "journey" is guided by the thick (red) arrow line with other thinner lines showing relationships or influences. A segment of the rich picture diagram of the pilot case storyline is provided in the figure 1.

4. Conclusion and further research

The development of the rich picture diagram to model the case studies storylines is explained to enable a macro view of the entire storyline whilst showing inter-relationships among different events and the project stakeholders at various points in the timeline.

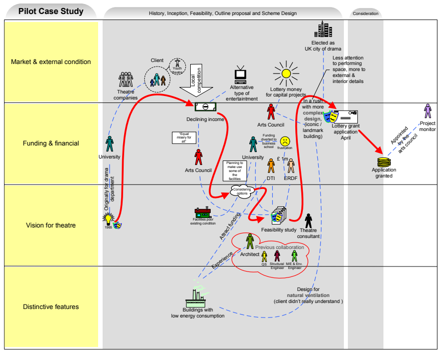

Figure 1: A segment of the pilot case storyline in a rich picture diagram format

This paper has demonstrated the superiority of developing rich picture diagrams in comparison to presenting case studies storylines in text format, particularly to facilitate research team discussions. Therefore, the use of the rich picture diagram to model a case study storyline can be recommended. Further activities of the research projects includes further data collection for the remaining case studies, and analysis with the grounded theory methodology including the development of the storylines of the case studies using rich picture diagram, leading to the cross-case analysis of the case studies.

References

[1] Barrett, P., Sutrisna, M., Sterry, P. Short, A., and Dye, A. (2006) Evaluation of Budgeting Histories in Arts Construction Projects: A Case Study, *In*: Aouad, G., Kagioglou, M., Harris, K., de Ridder, H., Vrijhoef, R., and van den Broek, C. (Eds.), *3rd International SCRI Symposium*, 3-5 April 2006, Delft, University of Salford, pp. 53-64.
[2] Harris, R. L. (1999) *Information Graphics*, Oxford University Press, Oxford
[3] Matthews, C. (2000) *A Guide to Presenting Technical Information*, Professional Engineering Publishing, London.
[4] Coyle, R.G. and Alexander, M.D.W. (1997) Two approaches to qualitative modelling of a nation's drug trade, *System Dynamics Review*, 13(3), pp. 205-222.
[5] Monk, A. and Howard, S. (1998) The Rich Picture: A Tool for Reasoning About Work Context, *Interactions*, March-April, pp. 21-30.

Local and global impacts: Spatial differentiation in assessments

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Life-Cycle Assessment (LCA) is a tool that offers decisional support to designers about sustainability of projects. LCA has been recently improved with the implementation of site-dependent factors, spatially resolved at the level of countries. The uncertainty in assessment due to spatial variation of effects is thus reduced. A further improvement may be achieved, in the future, by development of characterization factors spatially resolved at level of regions. This may give more precise information about impact of local products.

Keywords: LCA, spatial differentiation, environmental impacts, local building materials

1. Introduction

In the challenge to global environmental sustainability improvement, impact assessments are a useful set of tools. Within them, Life-Cycle Assessment (LCA) is a tool that allows the evaluation of environmental and energy loads of any product or service, thus it is a suitable instrument for the needs of designers, manufacturers and all the stakeholders in the implications of a project for the environment. The seriousness of environmental issues requires that designers have an increasing sensitivity to the theme of sustainability**;** to this end it is worth setting up support systems that help in the adaptation of strategies for the choice of materials and components. Those designers that care about the environmental performance of their buildings often choose local materials. That choice is supported, from the architectural point of view, by factors like the greater suitability of local materials through the use of traditional construction techniques and a greater adherence to the history and style of local architectures. In terms of environmental impact, local materials are usually preferred for the availability of raw materials and the low energy consumption for transport. The accessibility of raw materials, for example, is not necessarily synonymous with the great availability (in terms of quantity) of the resource, just as certain polluting emissions can have a more serious impact on the local ecosystem in one region rather than in another. A complete LCA must take into account, within the total impact scores, also the social effects connected to the economic activity of extraction of the raw materials and the production of building materials. It seems clear that, if up until now the evaluation of damage was based on average data referring to a whole continent, the possibility to base the analysis on more local parameters gives the LCA greater value. In the first versions of LCA-related methods, the effect variation given by the place of release for an emission was not taken into account. Recently analysts have felt the need for that information provided through inclusion of a spatial differentiation of pollution sources. All these methods take into account a complete range of environmental questions, however, each of these is directed so as to give particular emphasis to certain aspects, allowing the analysts to choose where to focus their evaluation on the basis of what they think is more pertinent to the product/service or to the environment which will suffer the impact, or also to look at aspects about which the commissioning group wishes to be informed. One of the most updated tools is the EDIP2003 methodology. Compared to the EDIP1997 methodology, the models underlying the EDIP2003 characterisation factors take a larger part of the causality chain into account for all the non-global impact categories [1].

2. Site-generic and site-dependent factors

The EDIP 2003 factors have been developed in a site-dependent and in a site-generic form. The site-generic form disregards spatial variation in dispersion and distribution of the substance and exposure of the target systems, like in the EDIP97 methodology. In the site-dependent form of EDIP2003, the characterization factors are spatially resolved at the level of countries, allowing the differences in impact from an emission, when released in different countries, to be a part of the characterization, as well as the exposure of target systems [2]. Therefore, the environmental relevance of the calculated impacts is higher. For many of impact categories, the potential spatially determined variation is very large.

3. An approach to understand the potential of site-dependent assessment

It is possible to comprehend the relevance of spatially determined variations in impact scores. The procedure shown in this work [1] can be seen as a sensitivity analysis based reduction of that uncertainty [3] caused by not using a site-dependent characterization. Considering the "acidification" impact category, there is a relevant difference between site-generic and site-dependent characterization factors. A three-steps procedure allows to identify those substances that most contribute to the impact score of a product, then to change their characterization factors to site-dependent factors, then to assess the impact according to the new process contribution due to the spatially determined variation of impacts. E.g., for the "acidification" impact category, the spatially determined variation between the most sensitive and less sensitive country shows a 10^3 factor.

4. Example: two light clay bricks made in different countries

In the building trade, local products are used as well as components coming from far away production sites. Usually local products should give a better environmental performance, however, impacts due to production processes will result higher or lower depending on characterization factors used for the assessment. The functional unit for the example consists of 10 kg of light clay brick, a very common building material, produced either in Italy or in Finland, which are two countries with very different ecosystems. The characterization with site-generic factors give the same results for both products. The site-generic factors give a result in which the largest acidification and eutrophication impacts are caused by Nitrogen oxides and Sulphur dioxides. The potential standard deviation is high and thus the results are affected by large uncertainty. A site-dependent characterization is performed for those processes that most contribute to impacts, and new results show that, the largest process contribution is due to Ammonia and Hydrogen chloride. However there is a large difference between impacts in Italy and in Finland because of spatially determined factors.

5. A research proposal for local building products and their assessment

In a comparison between two similar products made in different countries, there may be a great difference in the impact scores. The relevant differences in impacts calculated by the local (national) factors show that ecosystems are differently affected by emissions, and similary it is presumable that differences will also be found between regional ecosystems. Characterization factors have as a background the modeling of dispersion of each substance to the ecosystem. What would happen if we could use characterization factors determined at the regional level (perhaps a 200km range) ? Using region-resolved factors, the assessment would be more precise. Results given by such "regional" assessment could indicate the way to avoid resources consumption or establishment of productive processes in a region with a sensitive ecosystem just choosing, within the same country, another region.

6. Conclusions

The results of the above described research could be a decisional support not only for manufacturers, but especially for designers. The higher accuracy in impact scores given by a local (at regional level) characterization could give to designers the chance to assess the choice of a building material knowing the influence of the product's impact on the region of manufacture. Designers could thus prefer either local or non-local materials depending on what environmental performance is globally shown by a product, even if it comes from distant production sites but are all-in-all more sustainable due to a lesser impact on the local environment. A set of new region-resolved factors could thus help designers in the achievement of that sustainability at which they are aiming.

References

[1] Hauschild M., Potting J. (2005) *Spatial differentiation in Life-Cycle Impact Assessment – the EDIP 2003 Methodology*. Danish Environmental Protection Agency, Copenhagen,.

[2] Potting, J. and Hauschild, M. (2005) *Background for spatial differentiation in life-cycle impact assessment – the EDIP2003 methodology*. Environmental project no. 996-2005, Danish Environmental Protection Agency, Copenhagen.

[3] Weidema B., Fress N., Holleris Petersen E., Ølgaard H. (2003) *Reducing uncertainty in LCI – Developing a data collection strategy*. Environmental project no. 862-2003, Danish Environmental Protection Agency, Copenhagen.

Converting construction costs to a common currency base: An unresolved problem

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There is no generally accepted method for bringing construction costs in different national currencies to a common base. Exchange rates are generally considered to be inappropriate and a variety of other methods have been tried, most notably the use of purchasing power parities (PPPs). Their use in the construction context is, however, still considered either inappropriate or unreliable by many. Several studies are reviewed here and it is shown that the conclusions drawn by the authors of those studies vary considerably when different conversion methods are employed, and in some cases quite contradictory conclusions emerge.

Keywords: Construction industry, cost conversion, purchasing power parity

1. Introduction

International comparisons of output, performance or productivity generally require some conversion of values (cost, price or value of production, value added or some similar measure) from the national currency of the producers to some common base, typically US dollars. Many authors suggest that market exchange rates are not appropriate as they do not necessarily reflect price differences between countries. The method chosen for conversion can have very significant effects on the results and conclusions that emerge from international comparisons, however, the options available for conversion are limited.

2. Conversion options

Apart from money market exchange rates there are basically two available options: one is the use of some sort of purchasing power parity (PPP), the other is the use of the price of a standard commodity (also a sort of PPP), the best known of these being the Big Mac hamburger.

Purchasing power parities have been published by various organisations for some years. The OECD publishes a range of PPPs, both general and industry-specific at about three year intervals.

The Big Mac has been used since the 1980s and has gained some, if limited, support from various authors in recent years.

3. Previous studies

When alternative methods such as PPPs are used to bring costs to a common base outcomes change, sometimes quite dramatically. To illustrate this problem three st6udies produced over the past 20 years are re-examined. While the authors of these studies used a variety of conversion methods none used PPPs. In their 1986 study [1] Flanagan *et al.* used a notional exchange rate to compare US costs to UK costs. On the basis of their calculations the authors concluded that their data lent "no support to the notion that UK construction costs [were] significantly higher than UK costs for comparable construction." However, if their cost data is converted to a common currency using PPPs the six UK office projects studied appear to be between 50% and 124% more costly than the comparable UK projects.

In 1993 Lynton plc [2] used a completed UK office building as the basis for a hypothetical project of identical design and specification "constructed" in Charlotte, North Carolina. Charlotte was selected as the location for the hypothetical project as, based on a chosen exchange rate, this city had input costs very similar to UK costs for labour, supervision and basic materials. The exchange rate used was a 10 year money market average rate of \$1.60 = £1. In this study the exchange rate used was actually very close to the general PPP (\$1.57 = £1), and not greatly different to the construction specific PPP for 1993 (\$1.71 = £1). The Lynton study concluded that the US cost for an identical project was practically the same as the actual UK cost – only when the design was adjusted to reflect expectations and requirements typical of US clients did the US cost fall significantly below the UK cost (-32%). If, however, the costs are indexed to 1999 prices and the US estimates are converted to GBP using three different 1999 factors (i.e. 10 year average rate, general PPP and construction PPP) the costs of US construction relative to the UK are –17%, -13% and –2% respectively. This is due to some extent to changes in tender price indices in the in the two locations in the period 1992-1999: the UK Tender Price Index rose 36% while the US rose less than 16%. Using the estimated cost for an amended design, as described above, US costs appear much lower than UK costs regardless of the conversion factor used: -44%, -41% and –33% (10 year average, general PPP, construction PPP respectively).

The third study, published in 1999, was a pure cost comparison based on seven hypothetical projects priced in seven countries [3]. Initially costs were converted to AUD using current exchange rates - in this paper only the estimated costs for office buildings are discussed. Based on those costs (in AUD) the authors of the first stage report suggested that "it would appear that Australia with its currency exchange advantage is more than competitive with the other Western countries and on a par with Singapore". If costs are converted using PPPs, Australia appears to be considerably more expensive than most of the other Western countries included in the study, with the Germany the exception.

In a subsequent analysis of the same data Langston and de Valence sought to avoid the exchange rate problem by using the Big Mac Index [4]. On that basis Australia appeared to be more expensive than all but one of the other six countries, and the most expensive of the four Western countries. If general PPPs are used instead of the hamburger index Australian costs appear to be 8% and 10% higher than UK and US costs respectively; with construction PPPs the Australian figures are 27% and 13% higher. Once again it is clear that the use of alternative conversion methods changes the outcomes considerably.

4. Discussion

The foregoing discussion highlights the problem of bringing construction costs to a common currency base when making international comparisons of construction industry performance, productivity and/or cost. Studies that use well-considered methodologies for making such comparisons can produce highly questionable conclusions if the currency conversion is not properly handled, and those conclusions may be adopted by subsequent researchers and the unsound outcomes carried forward into other studies.

While a more reliable method is needed, there is ongoing debate as to what is the most appropriate approach. The bills of quantities (BOQ) approach is widely regarded as too cumbersome and expensive; baskets of construction components (BOCC) and goods (BOG) have been suggested but require further development. A successful approach, whatever its basis, should be built around the notion of purchasing power parity (to deal with price differences), should be industry specific, and should satisfy the basic requirements of representivity and comparability. It also needs to be time and cost effective in use to allow for greater frequency of data collection and for data in individual countries to be collected from a wider range of sources.

5. Conclusions

To date there is no "correct" method available although the use of construction specific purchasing power parity appears *a priori* to be the most promising. There are, however, continuing problems with the production of reliable construction PPPs that will be applicable across many countries, and there is continuing debate as to how such PPPs should be calculated. Until widely accepted PPPs are available it seems prudent to use several approaches, compare results and look for trends rather than trying to arrive at definitive conclusions. This would be the case even if the cost conversion problem were totally resolved; while it is a concern that sits at the heart of the comparison problem there are many other variables (e.g. taxation) that need to be considered before valid comparison can be made.

References

[1] Flanagan, R., Norman, G., Ireland, V. and Ormerod, R. (1986) *A Fresh Look at the UK & US Building Industries*, Building Employers Confederation, London.

[2] Lynton (1993) *The UK Construction Challenge*, Lynton plc, London.

[3] DISR (1999) *International Cost of Construction Study. Stage One – Base Cost of Construction*. Prepared by Page Kirkland Partnership for Department of Industry Science and Resources, Canberra.

[4] Langston, C. and de Valence, G. (1999) *International Cost of Construction Study - Stage 2: Evaluation and Analysis*. Department of Industry Science and Resources, Canberra
www.isr.gov.au/library/content_library/BC-CoCStage2.pdf

The effects of the Internet on scientific publishing in civil engineering

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Open access is a new Internet-enabled model for the publishing of scientific results, in which either the published articles are freely available on the Internet for anyone to read, or copies are made available in subject-based or institutional repositories. During the 1990's hundreds of individual open access journals were founded by groups of academics, supported by grants and unpaid voluntary work. During the last five years other types of open access journals, funded by author charges, have started to emerge. This paper reports on the experiences of the Electronic Journal of Information Technology in Construction journal, which also has been benchmarked against a number of traditional journals in construction IT and economics. The analysis shows that it is equal to its competitors in most respects, and publishes about one year quicker. The experiences of setting up a subject-based repository in the same field are also reported on.

Keywords: Internet, Open Access, Publishing

1. Introduction

Currently we are witnessing a very fast change in scientific communication from paper to predominantly electronic distribution of scientific journal articles. Yet the full potential of this change has not been fully utilised, due to the lack of competition in the area of journal publishing, and the unwillingness of the major publishers to change their currently rather profitable subscription-based business models. In the early 1990's scattered groups of scientists started to experiment with a radical new model, nowadays called Open Access, which means that the papers are available for free on the Internet, and that the funding of the publishing operations are either done using voluntary work, as in Open Source development or Wikipedia, or lately using author charges.

This process worked well until the mid nineteen nineties. The quick emergence of the Internet, where academics were actually forerunners as users, radically changed the situation. At the same time there has been a trend of steadily rising subscription prices ("the serials crisis") and mergers of publishers. In reaction, a new breed of publications emerged, published by scientists motivated not by commercial interests, but by a wish to fullfil the original aims of the free scientific publishing model, now using the Internet to achieve instant, free and global access.

It is not only the publishing itself, which is becoming a battleground between commercial interests and idealistic scientists. Since the emergence of data base technology in the 1960's a number of commercial indexing services have emerged, which libraries subscribe to. Traditionally these have relied on manual and or highly structured input of items to be included, a costly and also selective (and thus discriminatory) process. Now scientists are building automated web search engines which use the same web crawler techniques as used by popular tools, such as Google, and which apply them to scientific publications published in formats such as PDF or postscript. The combination of free search engines and eprint repositories is providing what is called the green route to Open Access. Currently around 15 % of journal papers are estimated to be available via this route.

A repository for construction IT papers was set up as part of the EU-funded SciX project (http://itc.scix.net/) [1]. Currently the repository houses some 1000+ papers, with the bulk consisting of the proceedings of the CIB W78 conference series going as far back as 1988. The overall experience with the ITC repository is mixed. Ideally agreements should have been made with all major conference organisers in our domain for uploading their material, at least in retrospect. This was, however, not possible due to copyright restriction, the ties between conference organisers and commercial publishers, fears of losing conference attendees or society members if papers were made freely available etc. Due to problems like this the repository has not reached the hoped for critical mass.

2. Benchmarking ITcon

The Electronic Journal of information technology was founded in 1995 as the first Open Access journal in civil engineering. It has since been followed by the International Journal of Design Computing and the Lean Construction Journal. ITcon is now well established and publishes 25-40 papers per year, on a par with a traditional quarterly journal [2]. ITcon uses the normal peer review procedure and the papers have a traditional layout. Other Open Access journals have experimented with alternative forms of peer review and more hyper-media like user interfaces, but our experience is that what is most important to authors and readers is rapid publication and easy access.

ITcon has recently been benchmarked against a group of journals in the field of construction information technology and construction management [3]. The studied factors included: Journal subscription price, Web downloads, Impact factors, Publication delay, Acceptance rate.

The subscription prices are easily available from the journal web sites. In order to make the results comparable the yearly subscription rates were divided by the number of scientific articles. The price per article ranged from 7.1 to 33.3 euro (Figure 1).

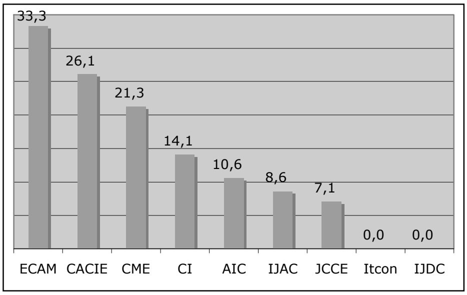

Figure 1. The price per article in Euros of the benmarked journals (for details see full paper).

Society journals often offer very advantageous individual subscription to members, which tends to increase the readership. Consider for instance the above figure, in which ECAM, CACIE and CME are published by big commercial publishers, and JCCE by a Society. Also IJAC is essentially a journal published by the eCAADe society, with its sister organisation on other continents. In practice commercial journals have often opted for much smaller subscription bases where their overall profits are maximised.

Readership is one factor for which it very difficult to obtain data. First the number of subscribers, in particular institutional subscribers, does not equate to the number of readers. Second most journals tend to keep information about the number of subscribers as trade secrets, since low numbers of subscribers might scare off potential submitting authors. Data on the downloads of published papers by readers could only be studied for one of the journals. For ITcon the web download figures (excluding robots) from the past three years were used. Over the three-year period each of the 120 published papers was on the average downloaded 21.2 times per month.

For ITcon the full publication delays where calculated from available databases. For some journals complete or incomplete information could be gathered from the submission and acceptance dates posted with the articles and the publication delay ranged from 7.6 to 21.8 months.

Construction Management and Economics has made quite detailed statistics on submissions and acceptance rates available on its web site, and over the period 1992-2004 the acceptancy rate was 51%. Also the ASCE journal for Computing in Civil Engineering has recently reported its acceptance rate to be 47 %. The overall acceptance rate for ITcon was calculated from the records and proved to be 55%.

All in all the experience with ITcon has shown that it is possible to publish a peer-reviewed journal which is on par with the other journals in its field in terms of scientific quality, using an Open Source like operating model, which requires neither subscriptions nor author charges. ITcon outperforms its competitors in terms of speed of publication. Concerning the total amount of readership it is impossible to obtain comparable figures for other journals. The analysis of journal pricing does, however, indicate that the pricing of some journals is so high that the number of subscribers is likely to be low.

References

[1] Martens, B., Turk, Z., Björk, B.-C.: The SciX Platform - Reaffirming the Role of Professional Societies in Scientific Information Exchange, EuropIA 2003 Conference, Istanbul, Turkey.

[2] Björk, B.-C., Turk, Z., Holmström, J.: ITcon - A longitudinal case study of an open access scholarly journal. Electronic Journal of Information Technology in Construction, Vol 10. pp. 349–371 (2005). http://www.itcon.org/

[3] Björk, B.-C., Holmström, J (2006). Benchmarking scientific journals from the submitting author's viewpoint. Learned Publishing. Vol 19 No. 2, pp. 147–155.

From formulation to appropriation: The importance of communication in strategy design and implementation

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Based on a field study in a large construction company, we follow the introduction of a new business plan from its formulation to its appropriation by managers at different hierarchical levels. We found that although top management paid attention to the production of the strategies, far less care was devoted to their dissemination and interpretation lower down in the organization. This neglect made it difficult for lower level managers to appropriate the strategies.

Keywords: Communication practice; discursive activity; organizational strategies; sense making

1. Introduction

"Strategies take on value only as committed people infuse them with energy" [1]

This paper examines the ways in which strategies are communicated down the chain of command in a large Swedish construction organization referred to as company A. Special attention is paid to the middle management level. The study focuses on one regional business unit and follows a set of new strategies down two paths of that unit, i.e. two districts. Using Weick's framework [2] [3], the paper examines the different methods of working with the strategies and discusses the possible outcomes. We argue for the need to align strategies with the mindsets of the individuals of the organization so that the strategies may be better appropriated and enacted.

We apply four of Weick's [3] properties of organizational sense making on our empirical case: Sense making is: 1. Grounded in identity construction; 2. Social and enactive of sensible environments; 3. Focused on and by extracted cues; and, 4.

Since organizations are made up of individuals who make sense of the world around them, more attention needs to be paid to collective sense making when analyzing the dissemination and implementation of strategies. The results from such a study could help improve communication practices [4] [5] and provide organizations with a way to work proactively with strategy implementation thus avoiding "silent killers" [6].

2. Making changes through strategies

The strategies in company A are reviewed annually by top management and aligned with company operations. Although the strategies apply to the whole organization, they are mainly formulated to address regional managers. The strategic document in question, 2006, included 30 strategies grouped under the headings: "Customer", "Way of working" and "Co-workers". The strategies cover different aspects of these headings, for example *communication with the outside world* and *being sensitive to the clients needs* sorting under the heading "Customer".

At the regional level, managers, including the district managers, were called to a two-day off-site meeting to discuss and prioritize the 2006 strategies to fit the circumstances of the region. Meeting off-site was a symbolic means of giving prominence to strategy work, which in previous years had lacked structure.

At this meeting, 18 of the 30 strategies were deemed a priority for the region. Several controversies arose concerning the interpretation of these strategies. For example, the strategy *communication with the outside world* caused discussion especially among the district managers, who interpreted *the outside world* as the media, and considered this issue not to be their responsibility. It was nevertheless decided that to fulfil this strategy the districts would seek regular contact with the information department.

2.1. How did the districts handle strategy work?

This section describes how two districts, Alpha and Beta, dealt with strategy work. Both used meetings to discuss the strategies and worked directly in the document enabling them to visualise the changes made and action points proposed. What differentiated the groups were the respective district managers' stance and communication methods, which we claim has an implication in the implementation.

Alpha's meeting was a traditional, based on an agenda, with the district manager acting as chairperson and authority. It was held on site, lasting a mere 3 hours. Present were only the district management group and only the region's 18 prioritized strategies were discussed.

Alpha's interpretation of the 18 strategies differed from that of the regional group. For example, *communication with the outside world* was reinterpreted as referring solely to media contact and could therefore be redefined as lying outside the district's responsibility.

The district manager considered strategy work as a necessary ill even though he acknowledged the importance of strategies. He stated that he did not pay much attention to the documents or measures that the work produced.

District Beta's manager followed an entirely different approach. Like the regional meeting, Beta's strategy meeting took place off-site and over a period of two days. Besides the district management group, three lower-level managers participated.

The meeting was transformed into a forum for collective thinking and dialogue, with the manager acting as moderator rather than authority. He felt that strategies had to be goal-driven and all the employees needed to understand the strategies underlying warrants. He highlighted the importance of the members' affect toward the strategies: employees should believe in the strategies of the organization.

District Beta prioritized 16 of the 30 strategies. Out of the 18 strategies prioritized at the regional level, 12 were kept and four were replaced. The four locally prioritized strategies were deemed to be of concern to district Beta's particular context. As with Alpha, one of the de-prioritized strategies was *communication with the outside world* for the same reason.

The main difference between Alpha's and Beta's processing of the strategies was that Beta did not only use a goal-driven approach, in which the group assigned a concrete measurable and realistic goal to a strategy and then assessed what measures would be needed to fulfill the goal, they also used dialogue and reflection as communicative tools. This approach was not used in any of the other districts of the studied unit.

3. Conclusion

Making is the internal boundaries between organizational levels. Each level co-constructs its own environment, opportunities and constraints, and interprets new information on the basis of these contingencies. Thus members of each level extract the most plausible cues at a particular moment in time that will enable them to shape the environment such that they will then be able to enact it [3]. This means that there will inevitably be conflicts between the cues that are extracted and the meanings ascribed to the cues. The lack of precision in the formulations provided top-managers with cues to which they could ascribe their own plausible meanings. For middle managers it was far more difficult to find simple and familiar cues in what they referred to as "fluffy strategy formulations". The wider underlying intent and implications of the strategies were thus "lost in translation".

As Weick points out, sense making is grounded in identity construction and sensitive to shifts in context [3]. Thus managers' identities changed as they changed context: in one context they were subordinates, interpreting the strategies from the perspective of the voice of authority, in the other, they were that voice, translating the strategies to fit their local contexts and agendas.

Looking at the implementation process at company A, this study shows that the organization needs to actively work with involving all of the members in the strategic work. As quoted in the beginning of this paper, *"Strategies take on value only as committed people infuse them with energy"* [1], this should include all of the members of the organization not only the management.

References

[1] Mintzberg, H. (1994), "The Fall and Rise of Strategic Planning", *Harvard Business Review*, Vol. 72 No.1, pp. 107-114

[2] Weick, K. E. (2001), *Making sense of the organization*. Blackwell Publ.: Oxford

[3] Weick, K. E. (1995), *Sensemaking in Organizations*, Sage: Thousand Oaks, CA

[4] Okumus, F. (2003), "A Framework to Implement Strategies in organizations", *Management Decision*, Vol. 41 issue. 9, pp. 871-882

[5] Aaltonen, P. and Ikävalko, H. (2002), "Implementing Strategies Successfully", *Integrated Manufacturing Systems*, Vol. 13 No. 6, pp. 415-418

[6] Beer, M and Eisenstat, R. A. (2000), "The Silent Killers of Strategy Implementation and Learning", *Sloan Management Review*, Vol. 41 No.4, pp. 29-40

Recycled construction materials for urban infrastructure – non-technical barriers to sustainable use of resources

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Construction and demolition activities produce waste in very significant quantities and at the same time have a high demand for natural resources. Appreciating recyclables / reusables from construction and demolition processes as resources is an important contribution to a sustainable use of resources. Nevertheless there are still potentials to increase recycling rates and recycling quality for construction and demolition waste (C&DW). The study presented analysed the non technical options and barriers for C&DW recycling for the field of municipal road construction and urban infrastructure.

Keywords: C&DW recycling, urban infrastructure, actors, attitudes, institutional context.

1. Recycling for urban infrastructure construction

Under the guiding principle of a sustainable use of resources and a reduction of waste the use of recycled mineral construction materials (RCM) is an important issue that is dealt with in both, European and national policy papers and regulations. Within a construction industry that in general is developing less dynamically at present maintenance and renovation of an aging building stock and urban infrastructure are gaining relevance. At the same time urban infrastructure construction offers less critical options for the use of RCM. Nevertheless these options are still not yet used as desired and attitudes of actors concerning this issue vary considerably as the results of an earlier explorative study of IOER [1] show. This was the starting point for the analysis of non technological obstacles to the use of RCM for urban models of institutional innovation were drawn upon [4] [5]. From a theoretical perspective it became clear, that disturbances – in the case of individual actors initiating a reflection of consolidated action pattern – and destabilisations – in the case of institutionalised trajectories preparing a “window of opportunity” – are crucial elements of a model designed for the analysis of non technical obstacles to the use of RCM for public works construction [6].

2. Use of RCM as a change of action pattern and institutional innovation

To define model hypotheses and outline the design of the survey the project started with a theoretical analysis of the institutional and regulatory context. Since the use of RCM for public works construction was interpreted as an environmentally driven innovation within a highly institutionalized field of action valuable input was sought from action theory, theory of innovation and theory of institutionalization. In order to focus the non-technical obstacles to the use of recycling materials for urban infrastructure the perspective adopted was rooted in action theory. The use of recycling materials is analysed as a shift of action patterns from a conventional business as usual approach towards a revised action pattern that takes into account environmental concerns [2] [3]. Considering the highly institutionalized context of an urban infrastructure planning authority, defining a widely infrastructure construction that combined theoretical analysis with an empirical survey.

3. Attitudes and motivations of key actors

Based on this model, several hypothetical factors determining a shift towards the use of RCM for urban infrastructure construction were outlined. They were distinguished by their origin within the political, cultural or techno-economic system and their potential to either stabilise or destabilise the established trajectories of material use for public works on the one hand and the treatment of construction and demolition waste (C&DW) on the other. These factors also were the basis for the design of the interview guideline for the expert interviews with key actors from the construction industry and municipal public works departments. From the *political system* mostly programmes and regulations can be expected to affect the stability or destabilisation of a given trajectory. In general we can say that for Germany the national strategy for sustainability includes targets of reduced waste generation and resource consumption. Also existing regulations like the “recycling economy and waste act” and the recently enacted “landfilling ordinance” potentially make simple and cheap landfilling or downcycling "solutions" more difficult. This in turn has the potential to destabilise the flow of the C&DW disposal trajectory. On the other hand it is stabilised by regulations on groundwater protection. Even if actors are prepared to use RCM they often step back because of the risk of harmful substances be washed out of RCM.

Regarding the *cultural system* we can identify some soft factors that are potentially influencing the stability of trajectories. On the one hand public actors often are referred to as responsible for giving good practice examples, which may be interpreted as a "constructive disturbance" of consolidated traditional action patterns or trajectories. On the other hand for the individual actors but also in the public RCM often still have the image of first of all still being waste.

From the *techno-economic system* first of all prices of RCM compared to those of new materials have to be considered as driving factors. For construction materials prices usually are determined by regional supply and demand. Thus a local shortage of new construction materials (natural lack of mineral resources or economic shortage due to dynamic demand) can be expected to hinder a given trajectory of C&DW disposal. On the other side growing recycling facilities and technological progress has the potential to lead to high quality RCM at favorable prices which might lower the inhibition threshold to the use of RCM.

4. Survey results

Uncertainties of users: representatives of the recycling industry reported discriminations of RCM in public call for tenders and see uncertainties and lack of information on the side of the users as one major reason for this situation. On the other hand respondents from the municipalities point out, that even if calls for tender are neutral concerning the use of RCM, bidders often do not consider this option, but seem to prefer "proven solutions".

Quality assurance is central: According to these uncertainties the participants highlight the necessity of clear quality standards and quality assurance schemes. In particular it is criticised, that in most federal states RCM are still not approved as products for market but still formally considered as waste. A special issue concerning quality assurance for RCM pointed out by the participants is the problem of "black sheep". What is meant is that suppliers of RCM may be tempted to dilute high quality lots with low quality material "out of some dump". The approach most widely discussed to overcome this problem is the organisation of RCM suppliers in "quality associations" providing third party certifications of quality over the whole recycling chain.

Landfilling still an option: Questioned about the expected effects of amended waste management and landfilling regulations, the majority of the interview partners indicated that they were not too optimistic. From their previous experience they judge that still too many gaps might exist.

All in all the results of the project indicate, that after some years of "fashion like" [4] use of RCM the future has to be considered less optimistic – at least concerning a rise of substitution rates of natural resources. However there are still private and public actors on stage that support recycling targets, so that the situation should at least be stabilized on the current level.

References

[1] Finkenstein, C. (2002): Stoffströme und Flächeninanspruchnahme des Bauens und Wohnens, Studienarbeit, IÖR, Dresden; *(„Material flows and land consumption for building and housing")*

[2] Klusemann u.a. (2003): Zielgruppenspezifische Modelle zur Erklärung umweltrelevanter Entscheidungen in der Wirtschaft: Ergebnisse einer interdisziplinären Forschungsgruppe, Umweltpsychologie, 7. Jg., Heft 2 114-133, *(„Target group specific models for the analysis of environmentally relevant decisions in the economic sector")*

[3] Al Diban, S. (1995): „Umweltbewußtsein im Bauwesen", TU Dresden, Institut für Psychologie, IÖR, Diplomarbeit; *(„Environmental awareness in the construction sector")*

[4] Beschorner, T. et.al. (2005): Institutionalisierung von Nachhaltigkeit – Eine vergleichende Untersuchung der organisationalen Bedürfnisfelder Bauen & Wohnen, Mobilität und Information & Kommunikation, Marburg, Metropolis; *(„Institutionalisation of sustainability – a comparative analysis of the organisational fields construction and housing, mobility and information and communikation")*

[5] Zundel, S. et.al. (2004): Zeitstrategien ökologischer Innovationspolitik, Berlin, IÖW *(„Time-strategies of ecological innovation policy")*

[6] Blum, A.; Stutzriemer, S. (2005): Baustoffrecycling im kommunalen Tiefbau – theoretische Grundlagen und Befragungsergebnisse; Bericht zum 2. IÖR Forschungsforum; *(„Recycling of construction materials for public works construction – theoretical framework and survey results")*

Sensitivity analysis of a construction project total duration with Precedence Diagramming Method

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Construction project total duration is always a critical element for construction management. The object of the paper is to introduce Sensitivity Analysis of project total duration, versus basic parameters like standard production rates of resources or key resource availability. A model of an example project is realized with Precedence Diagramming Method (PDM). The effects of variations of productivity rates and of variation of the availability of key resources versus total project duration are observed, thus performing a sensitivity analysis with a heuristic method, in a simple way.

Keywords: Construction project, sensitivity analysis, PDM, productivity, resource availability.

1. Introduction

Time duration of construction project is often fixed in contracts with poor investigation of feasible working methods and effective job conditions. In best cases the estimate of total duration of construction projects is what we can call a scientific guess. Since in the design phase it is impossible to forecast the actual contractor's organization, his management approach to project work and his effective resource availability, often total duration of even big construction projects is fixed, for contractual purposes, by owner's engineers just looking at their past experience and forecasting how project's peculiarities can bias standard production rates. Total project duration is a basic element of construction. It concerns functionality and usability of the building to be realized, and, obviously, economic and financial commitment of owner and contractor. Nevertheless the planner has a unique certain datum: the work to be done. In fact in most common cases the owner doesn't know contractor's organization before the contract is signed. Planning and scheduling process is based on contractual and design specifications. So the planner will decide, on his/her personal experience basis, at least two basic parameters concerning the production capacity of the contractor:

- available resources, or the number of crews;
- production rate of each resource.

It is of evidence that these parameters are of paramount importance especially in the scheduling process, and, in particular, in calculation of total project duration.

Sensitivity analysis is a method of Decision Analysis that aims to include uncertainty in production process models. Sensitivity Analysis tests if feasible changes in the values of fundamental variables of a model affect final results [1]. The objective of Sensitivity Analysis is to quantify changes in the final result because of a change in initial "key" inputs.

2. Sensitivity analysis of total project duration: proposed method

The proposed method was developed for repetitive projects planned with Precedence Diagramming Method [2], [3]. Project total duration is computed by performing the activity network's time analysis. Sensitivity analysis of Total Project Duration needs to change some input parameters. The parameters chosen are rpr (resource production rate) and the availability of resources, i.e. the number of crews available of a specific job type (e.g. carpentry). The change of these parameters defines some different scenarios for the construction project. The method is made of three steps. The first Step is the planning phase, the second Step is the Scheduling Phase and the third Step is the evaluation of results, i.e. the sensitivity analysis.

2.1 First step: Planning phase.

From an initial Project network, often planned using the hypothesis of unlimited resource availability, two new networks are developed. Network number 1 is the one expressed by minimum feasible resource availability, Network number 2 is the one expressed by maximum feasible resource availability [4].

2.2 Second step: Scheduling phase.

Time analysis for Network no. 1 (least resource availability) is performed using for all project activities the least values of resource production rate. Total Project Duration, with a value called TPD no. 1.1, is found, and this is expected to be the greatest value of TPD. Then time analysis for Network no. 1 (least resource availability) is now performed using for all project activities the greatest values of resource production rate. Total Project Duration TPD no. 1.2, is found. The same procedure is performed in time analysis for Network no. 2 (maximum resource availability). With the least values of resource production rate for all project activities Total Project Duration TPD no. 2.1, is found. With the greatest values of resource production rate for all project activities Total Project Duration TPD no. 2.2, is found, and this is expected to be the least value of TPD.

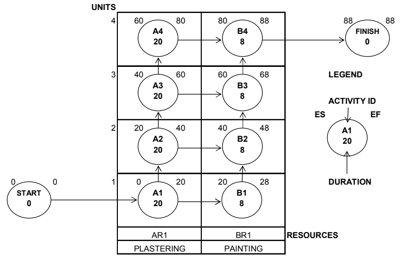

Figure 1. Example PDM Network

2.3 Third step: evaluation of results and sensitivity analysis.

To better show the results of the above procedure, found values of TPD should be plotted in a chart with the x –axis representing time and y – axis representing percentage of completion of the project in a scale from 0% to 100% [5]. (figure 2).

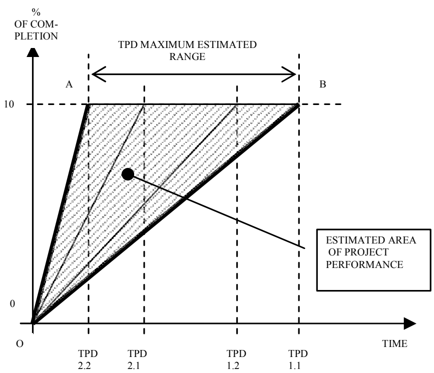

Figure 2. Sensitivity Analysis

The range between TPD 1.1 (point B) and TPD 2.2 (point A) is the estimated variation of Total Project Duration versus productivity and resource availability. The area between straight lines OA and OB and the straight line at 100% completion AB, represent the area where must be located the S – curve of construction project performance. The sensitivity of the project is represented by the area of triangle AOB. The greater is the area AOB the greater is the sensibility to inputs parameters, the smaller is the area AOB the smaller is the sensibility of the project.

5. Conclusion

Sensitivity analysis allows evaluating output changing of a model in relationship with input changing of key parameters [1]. Above it is proposed a simple heuristic method for sensitivity analysis of total project duration of a construction repetitive project versus variations in resource production rates and in crew availability. The first step is to develop two PDM project networks: one with the minimum feasible number of crews, another one with the maximum possible number of crews [4]. Time analysis is performed in these networks: first with the smallest possible resource production rates; second with the greatest possible resource production rates. Every one of the four scenarios founded has different total project duration. The values of total project duration (TPD) are plotted in a time / percentage of completion chart and evaluated [5]. The area bounded by extreme scenarios give a measure of sensitivity that can be evaluated and compared case by case.

References

[1] Saltelli A. (2002) Sensitivity Analysis for Importance Assessment *Risk Analysis*, vol.22, No. 3.

[2] Harris R. B. (1978) *Precedence and Arrows Networking Techniques for Construction* Wiley, New York U.S..

[3] Harris R.B. Ioannou J. (1998) Scheduling Projects with repeating activities *Journal of Construction Engineering and Management*, vol 1284, n.4.

[4] Yi K.J., Lee H. and Choi Y.K. (2002) Network Creation and development for Repetitive-Unit Projects *Journal of Construction Engineering and Management*, vol 128, n.3.

[5] Amato R. Chiappi R. (1997) *Tecniche di Project Management* FrancoAngeli, Milano, Italy.

Construction contractors as service innovators: A Swedish survey

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The purpose is to develop and apply a method for empirically surveying development activities and innovation among construction contractors. R&D efforts, innovations new to the firm and innovations that are new to the country are distinguished. New OECD definitions that recognize the service element in construction are applied. A characteristics based theory of service innovation has been used for a survey of the 50 largest Swedish construction contractors (88% response). Survey findings show that R&D and innovation definitions are crucial and that patterns vary with principal activities of firms and modes of innovation.

Keywords: construction contractors, research and development, innovation.

1. Defining and measuring construction innovation

The construction sector all too often appears as an inferior variety of manufacturing in the CIS and other surveys of innovation [1]. It seems that meaningful comparisons between these two sectors have to redefine construction along the value chain [2] or reconsider what is meant by innovation. Broadening the innovation concept implies being more generous (‘new to a particular firm’, rather ‘globally unique innovation’) or by including more than technology as an object of innovation. There has been a growing dissatisfaction with how surveys fail to capture service innovation [3].

However, the recent third edition of the OECD Oslo Manual [4] has modified definitions and can be taken as a new starting point for surveys of construction innovation. In the present version of the Manual, an innovation is defined as ‘the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisations or external relations’.

Thus, the purpose is to develop and apply a method for empirically surveying development activities and innovation among construction contractors. The project is supported by the Development Fund of the Swedish Construction Industry (SBUF).

2. Characteristics based service innovation theory

For studies of innovation in service industries, Gallouj [5] has proposed a framework where four variables are distinguished: (1) constituent services, (2) service mediums, (3) service characteristics (utilities) and (4) competences. Furthermore, there are the competences that are mobilized and the bundle of service characteristics that are related to customer utility functions. An example of an application of this framework is the mapping of innovation dynamics of hospitals.

This approach where innovation can be understood as driven by demand, oriented towards various characteristics of services, has been applied and extended to construction contracting here. Instead of ‘constituent services’ the principal activities of construction contractors are identified. The categorization of service mediums is retained. Service characteristics are interpreted as a set of sources of customer (client) satisfaction, to which is added a further set of internal effects of R&D and innovation. Competences are split here into level of formal education and ability to relate to particular groups of collaboration partners for R&D and innovation.

While earlier surveys of construction innovation provide guidance for identifying groups of partners for R&D and innovation, the categorization of sources of client satisfaction is more complicated. Studies of construction service quality dimensions inspired by the SERVQUAL scale, the development of Key Performance Indicators for construction and of non-price multiple criteria for contract awards inspired these eight sources of client satisfaction:

a) Higher technical quality
b) Higher esthetical quality
c) Higher technical quality precision
d) Shorter construction time
e) Higher construction time precision
f) Reduced local negative environmental effects
g) Reduced global negative environmental effects
h) Higher ability to communicate with client

For the internal effects of R&D and innovation, these categories were chosen:

a) More efficient production process

b) More stable capacity use

c) Better occupational health and safety for employees

d) Better leadership and relations between employees

e) Better relation to subcontractors or suppliers

f) Better image of the firm

3. Survey method

A questionnaire was sent early in 2006 to the fifty largest Swedish construction contractors, as measured by turnover in 2004. Six of these firms had more than 1,000 employees. Responses were received from 44 contractors (88 per cent). The first part of the questionnaire concerned basic data on the firm, while the second part was one form for each principal activity that the firm was involved in. Summing up over all firms there were data for 17 different principal activities, giving a total of 173 forms. The 2005 Draft Rev. 2 of the NACE code was used for classifying principal activities.

A distinction was made between R&D efforts, innovation new to the firm and innovation that is perceived to be unique nationally. Four categories of R&D and innovation were chosen: Material, Information, Knowledge and Relational. Four levels of formal education of employees were listed, as well as eight categories of collaboration partners. There were eight types of customer satisfaction effects and six types of internal effects of R&D and innovation.

4. Survey results

From the analysis of the survey responses, a number of salient findings can be reported. Many of these can be interpreted as patterns of coexistence between traditional R&D technology efforts and the exploitation of generic ICT for construction purposes:

- While Knowledge (Routines) is the most frequent medium for R&D in these firms, Material (Technology) grows in importance as innovations 'new to the firm' and is the dominant mode for innovations 'unique nationally'. Thus the definitions of R&D and of levels of innovation are crucial.
- There is considerable variety of principal activities among firms classified as construction contractors. On average, each firm had 4.6 principal activities. The five firms active in quarrying and manufacturing exhibit a stronger orientation toward R&D and innovation, together with a greater reliance on employees with a research degree and on linkage with universities.
- The two most frequent external linkages for R&D and innovation were clients and IT suppliers for the largest firms (1,000 and more employees), while clients and consultants were the most frequent for the rest of the firms in the survey. But the priority list of collaboration partners also varies with the principal activities.
- Most frequently mentioned sources of client satisfaction were 'better ability to communicate with client' and 'higher technical quality'. Among the perceived internal effects of R&D and innovation, 'more efficient production process' and 'better image of the company' received top scores. Once again, the ranking was quite sensitive to mode of R&D and innovation.
- From a policy viewpoint, it is noted that university linkage is strongly related to materials and technologies R&D and innovation and that European research collaboration is only found among the very largest contractors.

References

[1] Reichstein, T., Salter, A.J. and Gann, D.M. (2005) Last among equals: a comparison of innovation in construction, services and manufacturing in the UK. *Construction Management and Economics,* 23, 631-644.

[2] Winch, G. (2003) How innovative is construction? Comparing aggregated data on construction innovation and other sectors – a case of apples and pears. *Construction Management and Economics,* 21, 651-654.

[3] Djellal, F., Francoz, D., Gallouj, C., Gallouj, F. and Jacquin, Y. (2003). Revising the definition of research and development in the light of the specificities of services. *Science and Public Policy*, 30, 415-429.

[4] OECD (2005) *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data,* 3rd ed., OECD, Paris.

[5] Gallouj, F. (2002) *Innovation in the Service Economy: The New Wealth of Nations.* Edward Elgar, Cheltenham.

Global players in the world's construction market

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Typically, construction markets are characterized as local, not global markets and still there are companies that do business in many countries around the world. To bring order to this confusion we can distinguish between six different markets (regional, national, international, multinational, global, and transnational). On all of these markets specific products (or performances) are demanded by specific clients from specific construction companies. By looking at archival data of national and international construction activities it is possible to establish an allocation of companies to one of the six market strategies. From interview data collected on two types of mega-projects it is also possible to determine what characterizes a global player in construction.

Keywords: Global players, international construction, multinational construction, global construction.

1. Market strategies in construction

The construction industry has in principal the choice between five different market strategies: regional, national, international, multinational, global and transnational. [1]

The regional company concentrates on the local networks, is specialized in those networks and often also in some major segments such as building or some trades. Once a company has established a regional presence it can add additional networks in other areas. At the end of such a process the company becomes a national competitor by being active in most of the important regional markets of a country. National companies have a headquarter and many local subsidiaries. Other than the regional company, the national company has gained the competence to grow into different markets.

An international strategy is characterized by a large share of the revenues being generated in the home market and some additional activities in selected foreign markets. Construction services offered on foreign markets are specialized and limited to a small range. The number of countries served is also small. The behavior of the company is ethnocentric with a limited amount of knowledge of foreign markets. Despite all limitations, international companies must have the possibilities to form and manage the networks around their foreign sites responding to differences in culture and regulations.

If the activities in foreign countries contribute a larger share to a company's revenues and if these contributions come from many different foreign markets, then the company can be called multinational. Ethnocentricity is replaced be a polycentric behavior with strong orientations towards the different host countries. This, of course, implies a decentralized organization of the company with many top managers in the host countries having a local origin. A multinational company has many foreign subsidiaries. The ability to work in foreign environments and to build up networks in a score of different cultures is the main competence of the multinational company. Through its polycentric behavior such a company is prepared for and at ease in foreign environments.

Global companies are not simply active in more foreign countries than the multinational company but they use standardization of their products to achieve the highest possible economies of scale. They profit from a network spanning the globe to organize production. Managers come from countries around the globe, products are bought where cheapest, production is set up where labor costs are low. The orientation of the company is not tied to any one national culture, it is global, the behavior is polycentric. The important point for this strategy to work is, however, that the products can be standardized. This is not an option for the construction industry. Transnational companies are combining the advantages of global strategies for inputs wit a differentiation of outputs. Table 1 contains an overview of the numbers of companies in the different markets for Germany.

Table 1: Number of German companies in different geographical markets [2], [3], [4]

Market	Companies
Regional	~ 80,000 (100 %)
National	> 1,500 (1%)
International	~ 250 (0.3%)
Multinational	~ 5 (0.01%)
Global	2 (0%)
Transnational	0

2. International construction

The total value of construction spending has been estimated to be around 3.9 trillion US dollars for the year 2002. In the same year the top 225 international contractors had a revenue of 117 billion US dollars from overseas operations, which is equivalent 3.4% of construction spending [4]. The interpretation of these data is clear: About 95% of the global construction spending is allocated on local markets to local and national contractors. It definitely shows that the construction market is not a global market. Whatever happens in China is of very little interest to most construction companies in the US.

The sum of the international revenue of the top ten construction companies amounts to 56 billion US dollars which is 48% of the worldwide international revenue (117 billion US$). Yet the market share of these ten companies of all national markets is merely 1.4% (56 / 3,900 * 100 = 1,4 %). This tells us that there are no global players in construction holding a recognizable market share.

3. Global players in construction

The above figures are output-oriented. If it is, however, true that construction companies sell their performance potential, another question could be if there is a potential that is demanded by a global market. So the idea would be to look no longer at markets from the supply side but from the demand side. A tentative answer to the question whether there is a global demand for a specific construction potential is yes and this with regard to international mega-projects.

5.1.1 Miller/Lessard have studied mega-projects around the world and the average contract size in their sample is 985 mill. US dollars [5]. They require cutting-edge technology. Structures included in the sample are hydroelectric projects, thermal and nuclear power projects, urban transport, roads, tunnels, bridges, tunnels, oil projects, and technology projects. Not included are buildings and manufacturing structures. Beside the technology the companies involved in mega-projects need the ability to deal with the extreme complexity of such projects which includes the ability to establish the necessary network around the project in any part of the world.

In a study of several infrastructure mega-projects in Thailand (expressway system) and in Taiwan (high speed rail) we found some striking evidence of globalization to support the mentioned hypothesis. There are four indicators of such specifics: The perception of complexity, the goals of the companies, the type of organization, and the use of constructs. The interviews were conducted with managers from the USA, the UK, Germany, the Netherlands, Australia, Japan, Thailand, Taiwan, Korea.

4. Survey results

Regardless of the different national and company backgrounds the interviewees describe the overwhelming project complexity as the main characteristic of mega-projects. They expressed in unison their goals as being mainly to generate a profit and to eliminate all obstacles that endanger this goal. Customer satisfaction is for example not seen as a goal per se but as a stepping stone to profit. Even Japanese managers point out that they will most likely work only once for this mega-project client and then customer satisfaction serves no purpose. There are no differences in organization. Decentralization was seen by all managers as the only option to deal with the inherent project complexity. One Korean joint venture set up a hierarchy and found that it did not work. Even a construct such as trust was seen by all interviewees in the same way as a tool to decrease complexity. All these findings are somewhat in contradiction to the literature on international marketing and organization theory and therefore quite surprising.

All these indicators point in the same direction as the archival data: There is a select group of companies engaged in global projects around the world. They standardize across cultures and organizations what they offer on these markets, their potential to execute mega-projects. Such companies are the global players in construction.

References

[1] Meffert H. and Bruhn M. (2000) *Dienstleistungs-marketing: Grundlagen – Konzepte – Methoden,* Gabler, Wiesbaden.

[2] Hauptverband der Deutschen Bauindustrie (eds.) (2003) *Die Bauwirtschaft im Zahlenbild,* Berlin.

[3] Russig V., Deutsch S. and Spillner A. (1996) *Branchenbild Bauwirtschaft,* Duncker & Humblot, Berlin.

[4] Reina P. and Tulacz G.J. (2003) The top 225 international contractors avoiding volatile markets. *Engineering News Report,* Aug. 25, 2003, 28-32.

[5] Miller R. and Lessard D. (eds.) (2000) *The strategic management of large scale engineering projects,* MIT, Boston.

Public Private Partnership as innovation in services: global solution, local issues

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Public Private Partnership (PPP), a global innovation in services, is locally implemented in very different ways in the countries. PPP is mainly considered as an organizational innovation, evolving according to a methodological trajectory, implemented through local construction and management business systems. Three case studies are analysed in the UK, Italy and France. The differences among the three countries rely on differences of political understanding of PPP, of national culture and of the kind of local construction and management business systems put into action. In the conclusion, a method to analyse the complexity of PPP as innovation in services is proposed.

Keywords: Public Private Partnership, organisational innovation, innovation in services, construction business system.

1. PPP as innovation in services

In the present paper, PPP is analysed as an innovation in services. The theoretical analysis framework is a neo Schumpeterian approach of innovation in the service economy The result of a PPP procedure is a package of a product (the facility) and services (the funding and the management of the facility), one of the five kinds of services specified by Gallouj [1]. It is mainly an organizational innovation, one of the four kinds of innovation specified by Sundbo [2].

2. Three case studies in the UK, Italy and France

Three cases are studied: a 94 millions € thirty years contract for a hospital in the UK, a 29 millions € thirty years contract for a students' home in Italy and a 24 millions € twenty five years contract for a police building in France. The case studies are chosen among the ten European buildings PPP cases analysed in [3].

3. Very different packages of products and services

In the three cases, PPP is a package including a product (a hospital, a students' home, a police building) and services (the funding of the investment and the management of the building during 25 or 30 years), but the services provided are very different from a case to another. Higher is the service provided by the private sector, higher is the transfer of risks from the public authority to the private partner and higher is the price paid by the public sector.

4. PPP can be not only an organizational innovation but also a process innovation

In the Italian and French cases, PPP is mainly a new way to manage the modes of financing, building and operating public buildings. It is essentially an organizational innovation. In the British case, PPP is also the beginning of a process innovation, which is a change in service elaboration procedures, even if more recent British PFI projects quality processes, such as the Treasuring Building refurbishment one, are much more innovative. PPP can also be a service innovation when a new service is proposed.

5. PPP can evolve according to not only a methodological but also an informational trajectory

As it was already said, PPP uses new formalized methods to carry out the package product plus service. It evolves mainly according to a methodological trajectory. But in the British case, the innovation begins to deal also with an informational trajectory.

The information processing trajectory requires new data, new uses of data, networks sharing of information. PPP can also follow a material transformation trajectory, with an alteration of the material basis of the service. This innovation is potential. After elaboration of long term real operation and maintenance costs data bases, this innovation should appear and alter the material basis of the service.

6. Four reasons to explain the different ways to implement PPP

A first explanation is the differences between the characteristics of the buildings: a hospital is more complex than a students' home or a police building. But three other explanations can be proposed. One is the political understanding of PP. In the UK, government, public bodies, especially Ministry of Finances and National Audit Office strongly support PFI and PPP, through the idea that private sector competences are much more efficient than the public sector ones.

In Italy, the understanding of PPP is very different. A lot of the PPP projects are negotiated by medium size or small local authorities with medium size private companies. In France, dominant ideology in public bodies is a mistrust of the private sector and profitability. Another explanation of the local differences is a cultural one. In the UK, the culture of the service is largely developed. In France and Italy, technical aspects are dominant among the public clients.

Another explanation of local differences deals with the type of local construction and management business systems implementing PPP. In the British case, the Special Purpose Vehicle Company is controlled by four private big companies. In the Italian case, the SPV Company is controlled by a medium size construction firm. In the French case, the SPV Company is controlled by a public bank and two of its subsidiaries.

7. A method to analyze the complexity of PPP as innovation in services

Basically, PPP, which always delivers a package of a product with services, is an organizational innovation, evolving according to a methodological trajectory. But, in a given political and cultural context, the features and the complexity of PPP, as innovation in services, depend on the competences and the technical (material and immaterial) characteristics mobilized by the players involved in the process.

When simplified typologies of service innovations and innovation trajectories, inspired by Sundbo and Gallouj ones, are used, three levels of complexity can be specified. As an innovation, basic PPP is an organizational one, a new mode of financing, producing and operating public facilities, following a methodological trajectory, with innovative new formalized methods to implement the organizational change.

If certain competences and technical characteristics are mobilized by the players of the construction and management business system, PPP can become a process innovation, with innovative changes in the service elaboration procedures, requiring most of the time an informational trajectory, with innovative new data, uses of data, network sharing the information.

If others competences and characteristics are mobilized, PPP can become a service innovation, producing a new service and the trajectory can concern material transformation, with innovative new ways to design and build the public facility, especially in a life cycle cost perspective. Intermediate complexity levels are possible, such as for example PPP as a service innovation without any material transformation of the building.

8. Conclusion

PPP is basically an organizational innovation following a methodological trajectory in all countries. In a given political and cultural context, with the mobilization of certain competences and technical characteristics by the players involved in the local construction and management systems, PPP can become a more complex innovation being able to create new processes and new services, and able to use new information processing systems and implementing material transformation of the building.

References

[1] Gallouj, F. (2002), *Innovation in the Service Economy: the new wealth of nations*, London: Edward Elgar Publishers.
[2] Sundbo, J. (1998), *The organisation of innovation in services*, Roskilde: University Press.
[3] Bougrain, F., Carassus J., Colombard-Prout M. (2005), *Partenariat Public Privé et bâtiment en Europe : quels enseignements pour la France ? Retour d'expériences du Royaume-Uni, d'Italie, du Danemark et de France,* Paris : Les Presses de l'Ecole Nationale des Ponts et Chaussées.

Application and verification of the process-driven risk management framework (PDRMF)

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Process-driven risk management framework is subordinated to the construction process. It implies a cyclical risk management process in all phases through which construction project passes. Key risks are identified for each phase from the beginning of the project to operation and maintenance.
Application and verification of PDRMF is done on a project involving a tunnel as a major infrastructure facilities and well known as a great source of risks. Eighteen experts who had in various ways significantly participated in the execution of similar project were involved and helped verify the efficiency and applicability of the framework. PP-Risk computer programme, an integral decision support system and questionnaire are used for this purpose. The application and the experts' verification has provided useful lessons that will be presented in the paper for future research and application of PDRMF.

Keywords: risk management, process, framework, tunnel

1. Introduction

In the global sense, risk management is the process that, when carried out, ensures that all that can be done will be done to achieve the objective of the project, within the constraints of the project [1]. Risks and their effects should be observed on all the key sites of decision-making throughout the project and by all the participants in the decision-making process. The management of risk is a continuous process and should span all the phases of the project [2].

To identify key risks for each phase of the project any detailed plan of work can be used. Process Protocol, a plan of work that divides construction process into four stages that comprise ten phases, with maps which show breaking down structure of high level processes into sub-processes [3] [4] provided a good base for process-driven risk management (PDRMF) [5].

2. Application of the process-driven risk management framework

The application of the PDRMF (Process-Driven Risk Management Framework) was demonstrated on the *Sveta tri kralja* Tunnel. This tunnel is planned as part of the Zagreb-Macelj Motorway that will link the capital of the Republic of Croatia with the Republic of Slovenia. The tunnel will be more than 5 km long, mostly running through the weakest rock categories of the hard soil-soft rock type, with high levels of groundwater and many natural landslides.

The application of the framework was tested in several steps.The first step was choice of experts to participate in the testing. A total of 18 experts took part, who had played an important role in the realisation of similar facilities in the past. In the second step all the experts were given the list of key risks. Since the tunnel is a future project whose execution has not yet started, all the experts agreed that the risk list was appropriate for first analysis and that project-related risks may appear during project execution. The third step was to determine risk exposure and form the risk priority list for each phase.

Qualitative analysis was carried out as follows:

1. Questionnaire-type forms made for each phase separately were distributed to all the experts, to serve as the first iteration in the process of determining risk exposure for each identified risk. The forms were adapted to the Analytic Hierarchy Process (AHP) [6] method and enabled making a series of judgments about interrelationships among the identified risks with reference to probability, time, cost and quality, and defining the mutual significance of time, cost and quality in each phase.
2. The comparison results were entered in the database of the PP-Risk computer programme, and a degree of inconsistency in judgments appeared in a certain number of cases.
3. After the results were entered in the database a two-part interview was performed with each respondent. In the first part the experts used the PP-Risk computer programme [7] to correct their judgments so as to achieve consistency in deciding. The process was fast and efficient because the experts were now well acquainted with the risks, had been given time to think about them more, and easily achieved consistency in deciding. In the second part of the interview the ex-

perts were requested to provide the appropriate risk response.

4. Finally the author of the research syntesised all results, taking into account all the judgments made by the experts, as well as the exposures and the appropriate risk responses obtained.

3. Verification of the process-driven risk management framework

The framework was verified using the questionnaire method. The experts filled in the questionnaire after they had suggested, with the support of PP-Risk, the appropriate risk response and after they were shown the results of risk management in all the phases through which the construction project passes according to Process Protocol. The structural questionnaire has 10 questions that required the experts to choose one of the answeres offered.

In their answers the experts verified the breakdown of the project in phases suggested in Process Protocol, the list and process driven risk management. They marked the PP-Risk computer programme, as the implementation of IT support for the framework, as *Very Suitable*. They marked the user interface as *Satisfactory*. All the experts found that using the framework helped them understand the process in construction *Much* or *Very Much* better. They also agreed that the framework is *Appropriate* or *Very Appropriate*.

4. Lessons learned from application and verification of PDRMF

The application of the framework and the experts' verification has provided useful lessons for future research and application. The lessons can be summarized as follows:

1. The experts supported the division of the project into 10 phases following the structure of the Process Protocol.
2. The list of key risks for all the phases through which the project passes is appropriate for the first analysis but it might be modified in the future as the project develops incorporating the project-related risks which may appear during project execution.
3. The AHP technique was found appropriate for establishing the risk priority list in the each phase of the construction process. Some participants were not familiar with this technique, so it is possible that this problem might occur in the future. This would suggest that all participants should be made fully aware of the AHP technique before beginning to use the system.
4. There was some difficulty experienced by the experts in trying to be consistent in all judgments, but aided by the PP-Risk computer programme participants were able to achieve consistency in their judgments. It was found difficult to make a large number of judgments at once and keep the consistency. Therefore, it has been suggested use is made of the PP-Risk computer programme at the beginning of the risk analysis. This led to the conclusion that each participant should be provided in the future with the PP-Risk computer programme to avoid this problem.
5. All the experts found that the framework helped them understand the construction process better and the assessment of risk.
6. The framework improves communication between all participants of the project throughout all phases. Project managers gather information on risk from all the relevant participants in the projects.

References

[1] Clark, R.C., Pledger and Needler, H.M.J. (1990), Risk analysis in the evaluation of non-aerospace projects, *Risk management*, Vol. 8, No. 1, pp. 17-23.

[2] Smith, N.J. (1999), *Managing Risk in Construction Project*, Blackwell Science Ltd

[3] Kagioglou, M, Cooper, R, Aouad, G, Hinks, J, Sexton, M & Sheath, D. (1998a) *A generic guide to the design and construction process protocol*. University of Salford, UK, ISBN: 0-902896-17-2.

[4] Kagioglou, M. Cooper, R. Aouad, G. Hinks, J. Sexton, M. & Sheath, D. (1998b) *Final report: generic design and construction process protocol*. University of Salford, UK ISBN: 0-02896-19-9.

[5] Ceric, A. (2003), *A framework for process-driven risk management in construction projects*, Ph.D. Disertation, Institute for the Built & Human Environment School of Construction and Property Management University of Salford, Salford, UK

[6] Saaty, T.L., (1980), *The Analytic Hierarchy Process*, McGraw-Hill, New York, NY.

[7] Cerić, S. Matić: *Decision Support System for Managing Risk in Construction Projects*, International Conference Priprava a realizacia stavieb, Liptovsky Jan, Slovakia, 27-29 April, 200, pp.39-45

Women as engineers in construction: a framework for analysis

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The construction industry in Sweden is a male dominated place of work. This is shown by all statistics and is often the theme in the debate about the industry's future with focus on the negative influences of gender segregations on societal development. The questions exists as to how to change this situation and find arguments for increasing and keeping women engineers in construction. This paper starts a discussion and connects gender issues to the construction industry by presenting a theoretical framework with a gender perspective for a proposed study. The study will focus on conditions for women engineers in this context using qualitative interviews as the principal research method.

Keywords: women engineering, women and technology, gender and technology.

1. Women engineers in construction

The construction industry is a male dominated activity as shown by all statistics in Sweden. The sex ratio is extremely unequal. Only 3 % of upper management, 16 % of the engineers and technicians, 5 % of the construction craftsmen and 1 % of the construction workers are woman. In the group of civil engineers and architects women constitute 20 % of the workers employees.

A questionnaire survey by the Swedish union for managers in construction shows that one of four managers does not want to increase the diversity in construction. One in six declares that competence is the main obstacle to women work possibilities in the industry.

Themes in the public and political debate are often the male dominance and the problems of keeping and increasing the women engineers. The basis for this debate is the opinion that the male dominance is negative for the development of the society and the future of the industry. It is a problem from a gender equality perspective and also a recruitment problem in an industry facing large retirements in the near future.

Little has been done so far. It is still difficult to keep the women in the industry. Today the knowledge about what the main obstacles are that exclude women is not sufficient. This paper presents a theoretical framework for a proposed study about women engineers dropping out of construction where qualitative interviews will be the principal research method.

The starting point is a literature review about established knowledge in gender theories and gender in work organizations to connect the subject of gender with the construction industry.

2. The gender perspective

Making gender is a deep structure in our culture and our social system according to Hirdman [1, 2]. The foundation for the gender theories are the two principals of the gender order, the distinction of the sexes (to keep men and women apart) and the principal of men as the common praxis. Men are generally considered superior to women and constitute the normal human being. What men do is normally more highly esteemed than what woman do. Both men and women are integrated in the gender order by maintaining it. The gender order rules before and in other orders and interacts with class and ethnicity and with occupation and position in work organizations. Hirdman means that the gender contract is featured by a constant undergoing of integration and segregation which just update the gender contract. Women have their own room and conditions in male dominated work organizations. With increased visibility of the gender order it is possible to make a change.

3. Gender segregation

Gender research in male dominated work organizations is reviewed here with the female engineer and the construction industry in view.

The Swedish Government Official Reports of the gender segregated Swedish labor market [3] state that the segregation in the Swedish labour market has been reduced but the gender differentiation remains. That is in spite of investment efforts made to increase women's interest in technology to satisfy the need for professionals in the labour market. According to the reports it is a question about different conditions for men and women. A seemingly gender integrated occupation can still be gender segregated. The reports explain that gender segregation exists in different dimensions, *vertical* (men and women reach different levels in their career) and *internal* (different tasks or expertise in the same work). A common explanation is about the separate areas of interest for women and men. But this can be a consequence of exclusion obstacles which require closer examination. The reports give three explanations of the unequal working conditions where the question of power is one. Secondly, women are as well qualified as men but myths about their competence exist. A third reason pointed out in the reports is the representation of different generations in working life that influence and contribute to the gender segregation.

Kanter [4] found that the structures in work organizations decide possibilities for success and the experiences from working life form the human. Three conclusive factors should be studied- possibilities, power and the number of various kinds of people to reach understanding. Women and men are in equal positions in work but the career possibilities look different. Kanter means that women are in a minority position and segregation arises. The possibilities to gain sponsors and alliances with equals are rare. Women develop stereotyped strategies to cope, often placed in a gender specific position made by the work organization e.g. positions where there is less need for control as routine work, technical specialists or expert positions without decision making.

Abrahamsson [5] discovered that the segregation in work demands a picture of the organizations starting position with focus on the gender order to make a change instead of a restoration that only means an updated gender order. Otherwise a new construction of gender and a sorting according to gender occurs. But in a long perspective a slow improvement can be seen, new structures, new competences are asked for and new basics grow up. A so-called *restoration of changes* emerges as a positive effect. The existing culture and the configuration of gender are determining factors to refer to or make visible to be able to meet the force of restoration and bring about a change. Abrahamsson concludes that the gender order is a central principle in work organization changes by its sorting mechanism.

4. The empirical study

The aim of the study is to use a theoretical gender perspective to explore and explain why women engineers drop out of the construction industry. *Why do some leave and why do others stay? Which are the obstacles and conditions for women in this context?* And furthermore to find tools to update the industry and make guidelines for a change. An initial pilot study [6] constitutes the basis of the project. It shows that about 30 % of the women graduating MSC in engineering from technical universities in Sweden during a period of ten years at different periods left construction. Qualitative in depth interviews with women engineers will be the principal research method. They all have experiences from construction and made different choices about their career, in or outside the industry.

5. Discussion and conclusions

The question of how to increase the proportion of women engineers and keep them in construction is of high importance for the industry. Not much has been done so far. A deepened need for condition analysis and increased awareness of the changes of structures is necessary to improve the women engineers working life. This paper starts a discussion and connects gender issues to construction.

When summing up the theoretical framework, parallels can be drawn between previous research about gender in work organizations and the women engineer in the industry, such as restorations, gender marked tasks, segregation and alliances just to mention some. To be confirmed as a women engineer means to be seen from a masculine perspective.

Based on the theories, gender and the gender order are significant and gender is constructed from the different conditions for men and women in construction. The study will illustrate what part the obstacle structure of gender has in the women's decision to leave or stay. All experiences and efforts by the women engineers can constitute an important source of inspiration for a change in the future with the perspective of gender.

References

[1] Hirdman Y. (1988) Genussystemet - reflexioner kring kvinnors sociala underordning. *Kvinnovetenskaplig tidskrift*, 3, 49-63.

[2] Hirdman Y. (2001) *Genus - om det stabilas föränderliga former*. Liber förlag, Stockholm.

[3] Statens offentliga utredningar, SOU 2004:43 (2004). *Den könsuppdelade arbetsmarknaden*. Edita Nordstedts Tryckeri AB, Stockholm.

[4] Kanter R.M. (1993/1997) *Men and women of the corporation*. BasicBooks, New York.

[5] Abrahamsson L. (2000) *Att återställa ordningen. Könsmönster och förändring i arbetsorganisationer*. Doktorsavhandling. Boréa Bokförlag, Umeå.

[6] Hedman - Péturson, E & Berggren, K (2005) Fler kvinnliga ingenjörer i byggbranschen. *Rapport SBUF,* Luleå tekniska universitet.

A case study on implementing CAD – based simulation in earthwork

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Discrete event simulation (DES) is considered to be a very promising management technique for decision making process in the construction industry. This paper suggests integrating simulation with other planning systems like CAD by means of a simulation related product model. A case study of a German railway line construction project is also presented to demonstrate the role and advantages of simulation in supporting and archiving the decision making process in many project phases.

Keywords: construction management, simulation, CAD, XML, Earthwork.

1. Introduction

DES enables stochastic and dynamic analysis of a system and helps consequently designing and describing its behavior over time. Nevertheless, simulation technique did not achieve a wide use in the construction practice yet. The main reason is the modeling complexity of construction processes, which differ with each project causing the modeling process to be uneconomic. The new approach is based on two theories which aim at simplifying the modeling process and establishing simulation in the construction practice. Those are developing special purpose simulation tools with simplified, graphical and user-friendly modeling methods and integrating them with other planning methods. This paper takes advantage of new advancements in hierarchical and object-oriented simulation concepts, like Petri nets, as well as in data management technologies, like eXtensible Markup Language (XML), in order to build up a simulation related road product model (SRM) as an integration interface between simulation and CAD.

2. System architecture and application field

The specific goals of the road construction simulation are to analyze the resource utilization, to determine the most economical composition of resource groups and to minimize haul distance taking surrounding conditions into consideration. The CAD-based simulation system is implemented as an add-on program on AutoCAD. The system consists of three individual components, which exchange data between each other: the data model, the CAD environment and the Petri nets simulation system.

The SRM occupies a central position of the whole developed concept and represents the data base where the project data is saved. It works also as an interface between the two other components. SRM contains data related to the structure and relationships of processes, machines, geometry and durations within a road project. According the SRM a road project consists of four classes: cut, fill, temporary store and landfill for excess cut material. These classes are linked together with an additional class which represents the haul road. SRM is developed independently from a 'root' product model and can be understood as a 'particle' product model to be linked with other product models according to new approaches in this field [1], [2]. All the data of SRM are saved in one file written in the eXtensible Markup Language (XML). The CAD component is an add-on program on AutoCAD, which operates as a graphical user interface for the simulation component. The SRM is integrated in AutoCAD, so that a project specific XML-document can be generated to include all user input. A simulators developing environment called PACE® underlies the developed special purpose, Petri nets-based simulation system. This environment enables building up own simulation systems. The basic idea is to construct a universal simulation model for a specific field of application, i.e. earthwork in road construction projects. All simulation parameters are kept variable till the data are written to the SRM. After that, the parameter get their values and the simulation runs considering the specifications of the studied construction site which are input by means of CAD.

3. Program structure

The input of the data is managed with various menus. The user gets access to these menus by an additional drop-down menu in AutoCAD named 'Simulation'. The drop-down menu consists of several menu points like 'project description', 'cut', 'additional locations', 'haul roads', trucks', 'soil strata', etc. project related data can be directly input or extracted from CAD. The menus give access to the XML-Document, which contains the SRM. The earth quantity calculation is also managed at a menu, by using the German exchange standard for quantity calculations REB (Richtlinien für elektronische Bauabrechnung) [3]. Finally, the sequence of construction can be defined by creating a Microsoft Project file out of the specified project data automatically.

4. The case study

The new approach is applied on heavy earthmoving construction and logistic operations within a railway line construction project in Germany.

The analyzed project is the construction of the ICE (Intercity Express) railway line between Ebensfeld and Erfurt which is a section of the new railway line construction project Nürnberg-Erfurt-Leipzig/Halle-Berlin. A lot of unevenness exists along this railway line construction area. The 6.2 km long distance contains six heights and seven deepenings with reference to the planned railway line position. In order to construct the required planum about 1,650,000 bank cubic meters (BCM) must be moved.

The project is constructed according a 'function building contract' that includes building the railway line and its maintenance over a longer period of time. Function building contracts aim at raising quality standards relating utilization in addition to construction methods and materials. However, they demand efficient instruments to enable analyzing more economical construction variants and accomplishing a kind of self control. A lot of conventionally documented project data are observed and machine cycle time data are collected on the construction site in order to regenerate the construction progress. Modeling stochastic simulation input demands selecting a theoretical distribution function that models the collected data. In order to determine the type of this function (Θ_1- Θ_2) diagram. The results confirm the study of AbouRizk and Halpin [4] in which they approved that flexible distributions, like beta distribution, are required to properly model the diversified characteristics of construction duration data.

The output for the first and second cuts is presented in this paper. The project is structured to include 6 cuts 'E1'….'E6', 9 fills 'D1'…..'D9' and two landfills 'Lf1', 'Lf2'. While the first cut is decomposed into 4 sections which consist of 17 soil blocks in total, the second cut is decomposed into 9 sections with 92 soil blocks. After this structure has been input by means of the developed program, the processes are listed automatically in a scheduling program, where the process sequence has to be input by defining the predecessor relationships. The simulation model is consequently generated and can be used to analyze the machine groups for each soil block considering its surrounding conditions and to evaluate many earth mass distribution alternatives. The first possibility offers a process analysis, which helps defining the best group of machines and thus increase the productivity. With the second possibility the simulation system enables a project-oriented view to analyze logistic and transportation processes in between the different work locations. Now many other possible alternatives can be simulated. Comparing the simulation output of each alternative supports decision making process during all project phases.

Conclusions

With the developed approach and its implementation the modeling process is simplified and the simulation is integrated with CAD and scheduling systems. Simulation promises even more potentials than maximizing resources productivity and predicting process cost and duration under realistic site conditions. It constrains transparency and structure at process and at project level, and it can be an excellent prediction, documentation and communication instrument.

References

[1] Kiviniem A., Fischer M., Bazjanac V. (2005) *Multi-model Environment: Links between objects in different building models,* Proceedings of the 22. conference on information technology in construction, Dresden, Germany 2005, pp. 227-8.4

[2] Tibaut A., Rebolj D. (2002) *More knowledge for less complex product models,* International Council for Research and Innovation in Building and Construction CIB w78 proceedings 2002, pp. 1-8.

[3] REB - Verfahrensbeschreibung 21.013 (1979) *Massenberechnung zwischen Begrenzungslinien,* Forschungsgesellschaft für das Straßenwesen

[4] AbouRizk S.; Halpin D. (1992) *Statistical properties of construction duration data,* Journal of construction Engineering and management Vol. 118 (3) September, pp. 525-44.

A comparative study of construction partnering practices between private and infrastructure sectors in Hong Kong

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Partnering has appeared to be an effective and non-confrontational approach to procuring construction projects in Hong Kong since its first adoption on the North District Hospital project in 1994. This paper analyzes and compares the applications and outcomes of project partnering practices between the private and infrastructure sectors of Hong Kong via four case study projects. By using structured interviews and empirical surveys, the partnering approach and process, major benefits of implementing partnering, key performance indicators (KPIs), together with overall project performances, are investigated and compared. The research findings indicated that both sectors adopted similar structured partnering processes and achieved very outstanding project performances. The infrastructure sector achieved better overall project performance with lesser dispute magnitude than the private sector while the private sector outperformed the infrastructure sector in 'quality performance', 'professional image establishment' and 'scope of rework'. It is recommended that partnering together with appropriate contractual arrangements, such as Guaranteed Maximum Price (GMP) and Target Cost Contracting (TCC) be adopted across a wider spectrum of the construction industry during the 21st Century to reap sustainable benefits for construction excellence.

Keywords: Comparative study, project partnering, private sector, infrastructure sector, Hong Kong

1. Introduction

An increasing trend in the adoption of construction partnering by clients has been observed in Hong Kong since its first application to the North District Hospital project in 1994 [1]. It is worth noting that both the private and infrastructure sectors implemented partnering principles with tremendous achievements in terms of time, cost and quality performances [2].

To investigate and examine the effectiveness and performance of project partnering as applied in the local building and construction industry, the Construction Industry Institute, Hong Kong (CII-HK) (http://www.ciihk.org.hk) commissioned a research team in March 2003 to undertake an industry-driven research study to analyze project partnering practices in construction. The study aimed to explore and compare project partnering practices amongst the public, private and infrastructure sectors based on six partnering projects completed between 1999 and 2002 in Hong Kong [2]. This paper particularly focuses on comparing project partnering practices between the private and infrastructure sectors of Hong Kong via four relevant partnering projects. The projects include two from the private sector and two from the infrastructure sector.

1. *Private sector building projects*
   Chater House – a prestigious rental commercial development in Central by Hongkong Land Ltd (HKL)
   1063 King's Road – a rental commercial development in Quarry Bay also by Hongkong Land Ltd (HKL)
2. *Infrastructure sector projects*
   MTRCL Contract 601 (Hang Hau Station and Tunnels)
   MTRCL Contract 654 (Platform Screen Doors)

2. Research methodology

A number of research methods were used in this study, which included (1) structured interviews; (2) case study approach; (3) the computation of Key Performance Indicators (KPIs); and (4) empirical questionnaire surveys.

3. Comparisons of project partnering practices between the private and infrastructure sectors of Hong Kong

Three kinds of analyses were undertaken to compare project partnering practices between the private and infrastructure sectors of Hong Kong via four relevant partnering projects, two for each sector [2]. The first analysis is the direct comparison of the Key Performance Indicators (KPIs). The second analysis is to compare partnering approach and process. The third analysis is to compare the relative rankings of the mean scores for the major benefits of partnering and overall partnering performances based on the responses from the empirical questionnaire. It is of interest to note that the findings are indicative in nature rather than conclusive because there are only four case studies for the private and infrastructure sectors and the sample size is small.

3.1 Major findings

1. All four case study projects were completed on time (with 2 infrastructure projects being ahead of schedule by 5% and 1 private sector building project being ahead of schedule by 0.63%), at reasonable costs, and to satisfactory quality.
2. All four case study projects adopted a structured partnering process, which includes one initial workshop, one or more interim workshops, and one final wrap-up workshop. It is worth noting that the two infrastructure sector projects had more frequent interim workshops. These workshops seem to help deepen the partnering spirit.
3. The two private sector building projects only engaged external independent facilitators whilst the infrastructure sector projects engaged both external and in-house trained facilitators to facilitate the partnering workshops. It appears that more flexibility can be built in through an internalized partnering arrangement but the benefits of having an external facilitator should not be under-estimated.
4. The infrastructure sector projects gained more benefits, exhibited better overall project performance, and encountered fewer difficulties from partnering implementation than the private sector. This can be attributed to the systematic approach of implementing partnering and the method-related nature of civil and E&M installation works, which entail a lot of discussions and co-ordinations amongst the interfacing project participants.
5. The private sector building projects had better quality performance, professional image establishment and scope of rework as indicated from the results of the questionnaire survey. Quality assurance has been widely accepted as an essential element in establishing a professional image among counterparts especially in the highly competitive private sector. Partnering is instrumental in shaping a professional image among counterparts by achieving quality and prestigious construction.

4. Conclusion

This paper has presented a holistic approach to compare the implementation and outcomes of project partnering practices between the private and infrastructure sectors of Hong Kong. In addition to the previous findings, it has been found that the development of 'Target Cost Contracting' (TCC) via 'Incentivization Agreement' (IA) in the two infrastructure projects and the 'Guaranteed Maximum Price' (GMP) contracing approach in the two private sector building projects are effective in fostering a co-operative working atmosphere with a gain-share/pain-share culture, which are largely derived from the perceived partnering spirit cultivated amongst all contracting parties. As a result, this study has generated good pointers to the successful implementation of partnering for improving overall project performance. However, it must be stressed that partnering is not almighty to fix all types of problems. What it does is to establish a platform for project stakeholders to communicate better for mitigating unnecessary misunderstanding and intractable disputes. As advocated by the CIRC's Report [3], partnering coupled with other appropriate contractual arrangements, such as GMP and TCC be implemented widely within the Hong Kong construction industry to strive for excellence in overall construction performance.

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References

[1] Chan, A.P.C., Chan, D.W.M. and Ho, K.S.K. (2002) An Analysis of Project Partnering in Hong Kong. *Research Monograph,* The Hong Kong Polytechnic University, 96 pages, ISBN 962-367-363-9.

[2] Chan, A.P.C., Chan, D.W.M., Fan, .L.C.N., Lam, P.T.I. and Yeung, J.F.Y. (2004) A Comparative Study of Project Partnering Practices in Hong Kong. *Summary Report*, *Construction Industry Institute – Hong Kong*, Research Report No. 1, 40 pages, ISBN 988-98153-3-8, September 2004.

[3] CIRC (2001) *Construct for Excellence*, Report of the Construction Industry Review Committee, Hong Kong Special Administrative Region, 207 pages.

Emphasizing disciplinary boundaries: was Belbin right?

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There is rising interest in inter-disciplinary working and integrated team working in UK construction over the last decade. However, we are still bounded by such functional roles as architects, builders, quantity surveyors etc. Inter-disciplinary working necessitates cross-cultural appreciation of the multitude of roles in construction and a rethink in education. This paper reports on a survey conducted on a group of 78 second year undergraduate students in a UK university. The specialisms cover architectural technology, design management, project management, construction management and interior design. The Belbin (2004) team roles questionnaire was used to identify particular tendencies of the students. The findings suggest architectural and interior design students to assume more creative team roles, whilst construction and project management students tended to undertake the role of team workers. The results highlight the need for more opportunities to be given to students to interact with various disciplines to achieve greater cross-cultural appreciation.

Keywords: cross-cultural appreciation, disciplines, education, team working, team roles.

1. Introduction

It is widely accepted that team working brings about opportunities for individuals to come together to solve organizational problems that are often complex and multi-dimensional. Alongside the growth in team working, the phenomenon of (and need for) inter-disciplinary working and thinking is increasingly featured in the business environment as well.

However, whilst the concepts of team working and inter-disciplinary working espouse business benefits in principle, the reality seems less certain. In construction, Moore and Dainty [1] found that intra-team disciplinary boundaries exist within design and build construction despite the intended integration of design and construction disciplines in such arrangement.

Indeed, for inter-disciplinary working and thinking to work effectively in construction, there needs to be cross-cultural appreciation of the multiplicity of roles involved in delivering the built environment. Proponents of inter-disciplinary working have often assumed that benefits to problem solving accrue on the basis of getting a range of disciplines together. It is argued that this assumption of getting people together has formed the thrust of many industrial and research initiatives promoting inter-disciplinary working, and resulted in the investment of research efforts into issues like knowledge management. However, it is maintained that deeper understanding beyond the mere coming together of people of how inter-disciplinary working is best employed has yet been established.

This paper presents an endeavor to better understand team working from a psychological perspective. Following the conduct of Belbin team roles [2] questionnaire on a group of second year undergraduate students undertaking a general management module in a UK university, it was discovered that inter-disciplinary working is not as straightforward as getting different disciplines together. The findings suggest that each discipline contains certain tendencies in relation to the team roles, and that such disciplinary silos potentially prevent the espoused benefits of inter-disciplinary working from taking place.

2. The research process

The sample for the Belbin [2] questionnaire survey derived from a common management module taught to second year undergraduate students pursuing a degree program in a UK university built environment department. The essence of the management module is the inclusion of the overarching emphasis of team working. All 78 students – consisting of 22 architectural technology students, 15 construction management students, 21 design/project management students and 20 interior design students – were asked to complete the Belbin team roles questionnaire during a timetabled lecture session. The results from the questionnaires were then collected and analyzed using descriptive statistics.

3. Findings

Thirty-three percent of the construction management students (CM) in this study emerged as implementers. However, CM scored lowly on shaper roles, with only 6% claiming shaper as a dominant role. Incidentally, only 9% of architectural technology students (AT) were dominant shapers. By contrast, a higher proportion of design/project management students (BDM/BPM) and interior design students (ID) appear to be shapers in this exercise. This reinforces the conventional thinking that links leadership roles with project managers and designers [8]).

As expected, designers are creative. This is supported by the relatively higher proportion of plants among both ID (20%) and AT (13%) students, as compared to BDM/BPM (9%) and CM (0%) students. Nonetheless, CM students appear to be very resourceful, with 20% claiming resource investigator as a dominant role. It is also fascinating to note that BDM/BPM students (23%) and CM students (20%) came out as more dominant in terms of the coordinator team role. Again, these findings reinforce stereotypical views of the nature of jobs held by project managers and construction managers in practice.

The findings presented in this section offer insights into the psychological traits of the built environment students concerned. The cliché that designers are creative and construction people are doers appear to be emphasized.

4. Implications

The findings presented in this paper make a potentially worrying read because there is some indication that the team roles mirror the functional disciplines that make up a construction project team – and not in a good way! For example, if more designers assume the shaper role, then the construction managers who feature lowly in this particular role within this study will possibly be sidelined, thus reinforcing the deeply-entrenched fragmentation of the industry. Similarly, if construction management students continue not to assume the monitor evaluator role, this can mean that construction managers of the future will be so caught up in doing the project that they lose sight of thinking and planning.

This then raises a number of questions that need to be explored in further research. First, how did these second year students come to possess these tendencies? Will these tendencies be reinforced as the students advance through universities? Will the students in turn take these tendencies into the workplace, thereby strengthen the fragmentation of the industry? Should more inter-disciplinary working be introduced into the curriculum so as to reduce the probability of reinforcing these tendencies? One way to help answer these questions could be to run the Belbin team roles questionnaire on first year and final year undergraduate students, as well as fresh graduates to see if the emergence of these team roles within the disciplines follows a clear development trajectory.

5. Conclusions and recommendations

In conclusion, this paper deals with the growing trend of team working and inter-disciplinary working and thinking in both practice and research. The paper highlighted that the underlying assumption of inter-disciplinary working, i.e. that getting various disciplines closer together is better, remains cursory. Therefore, the question was posed as to whether a deep understanding of inter-disciplinary working and thinking has been ensued in the industrial initiatives and research around the issue. By utilizing the Belbin team roles questionnaire to identify tendencies among a group of second year undergraduate students, it was found that stereotypes exist. Specifically, designers are creative whilst construction people are doers. It was proposed that the curriculum and culture of academic departments might be responsible for driving these silos and that further research needs to be undertaken to explore the extent to which this is true.

References

[1] Moore, D R and Dainty, A R J (2001) Intra-team boundaries as inhibitors of performance improvement in UK design and build projects: a call for change. *Construction management and economics*, **19**, 559 – 562.

[2] Belbin, R M (2004) *Management teams: why they succeed or fail*. 2 Ed. Oxford: Elsevier Butterworth-Heinemann.

The impacts of knowledge leakage in construction

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The move towards the knowledge economy necessitates a rethink of the role of knowledge in practice. The UK lags behind the USA and parts of Europe in terms of productivity. This research represents a multi-disciplinary, multi-sectoral project attempting to dissect the nature of knowledge and its impacts on the UK productivity gap. The research focuses on organizational knowledge flows, which can have positive and negative ramifications on the firm's productivity. To secure the long-term competitiveness and productivity of UK firms, there needs to be clearer understanding of the role of these knowledge flows in practice. Through exploratory interviews with senior managers of design firms, key issues regarding knowledge flows are elicited. The findings highlight knowledge flows as dynamic interactions between organizations and their supply chain, customers, competitors, collaborators and human resources. This exploratory phase contribute to the wider research aimed at developing taxonomy of these knowledge flows called knowledge leakage.

Keywords: design, globalization, knowledge leakage, outsourcing, productivity.

1. Introduction

The advent of the knowledge worker especially in the developed world, according to the late Peter Drucker [1], necessitates a productivity revolution where knowledge is a fundamental tool of production. Within much political rhetoric, the recognition of this productivity revolution has given rise to the emphasis of the knowledge economy.

Despite much hype surrounding the role of knowledge in boosting the performance and competitiveness of the economy, several commentators have expressed dissatisfaction with a lack of understanding of the nature of knowledge. Kelloway and Barling [2], for instance, commented, "as yet there is little consensus as to what constitutes 'knowledge work', making it difficult if not impossible to achieve (p. 287)". They added that the literature around the concept of knowledge has thus far repackaged "old wine in new bottles (p. 288)". Indeed, the understanding of knowledge remains, at best, in the abstract. Taylor [3] lamented on the level of abstraction and suggested that "honest probing is needed now, rather than glib answers".

This paper reports on research that is attempting such honest probing. The intention is to develop greater specificity of knowledge through what is called knowledge leakage. The research is borne out of a UK-funded program that investigates the nature of the UK productivity gap with countries like the USA (see http://www.aimresearch.org/ideas_factory.html).

Initial motivation of this particular research is concerned with growing trends of globalization and outsourcing, and the fear that organizations which outsource may inadvertently leak knowledge to another organization to the detriment of its productivity and competitiveness. The ultimate aim of research seeks to develop taxonomy of knowledge leakage to enable organizations to understand their organizational knowledge leakage and the resulting consequences. Early findings from a scoping phase of the ongoing research, which included a multi-disciplinary literature review and interviews with senior personnel from a range of organizations, are reported here. These findings suggest knowledge to result from the dynamic interactions between organizations and their supply chain, customers, competitors, non-competitive collaborations and human resources.

2. Research process

Eight organizations (of which three were related to the construction industry) from the research team's existing contacts were approached either by telephone or in writing. It was decided that interviews should be conducted with senior managers who has an overview of the organizational processes. A total of 10 senior managers were consequently interviewed in the 8 organizations. Each interview lasted between 1 to 2 hours and the questions revolved around the participant's view of their organizational knowledge, the associated knowledge flows and the effects on productivity. The interviews were recorded and transcribed verbatim for subsequent analysis.

3. Early emergent findings

Knowledge was categorized into dynamic interactions between organizations and their suppliers, customers, competitors, non-competitive collaborators and human resources.

Suppliers: there is awareness of knowledge leakage to suppliers of information in all cases. Organizations attempt to safeguard the critical knowledge of the business by controlling the types of knowledge that they outsource (standardized and repetitive) or maintaining as much of the knowledge base in-house as in the case of Participant B's organization. There is also a general perception that the higher value design work represents knowledge that should be kept secure. Also, smaller organizations are more inclined to outsource certain elements of work for efficiency gains, whereas larger organizations have the capacity perhaps to develop a range of complementary skills.

Customers: it is unsurprising to find that all the participants felt that it is extremely important to learn from the client, especially in terms of developing the design brief. All participants acknowledge the importance of maintaining customer satisfaction and that understanding the client's business is central to achieving success. On a similar point, it was noted that the participants preferred repeat businesses because this meant reducing the time spent to "reinvent the wheel".

Competitors: every organization is always tuned into what their competitors are doing. However, when quizzed about knowledge leakage to and from competitors, all the participants felt it was very difficult to illuminate exact leakage of knowledge and distill out the impacts on productivity.

Non-competitive collaborations: all the participants recognize the occurrence of knowledge leakage to non-competitive collaborators, e.g. Universities, industrial cluster groups.

Human resources management: knowledge leakage due to people leaving either permanently through retirement/resignation or temporarily through sickness/holidays can have a negative impact on productivity. Conversely, it was recognized that the recruitment people, especially from a competitor or customer, can be beneficial to the business.

4. Conclusions and recommendations

This paper reports on ongoing research into establishing the impacts of knowledge on productivity. Within the confines of this paper, the results of a scoping study are presented. The findings reveal knowledge leakage through dynamic interactions between organizations and their suppliers, customers, competitors, non-competitive collaborators and human resources. The preliminary findings appear interesting and pave the way for further work to test the concepts further. In-depth case studies will now be undertaken to obtain deeper insights into the key emergent issues provided here. It is believed that the research described here offers greater specificity and holism to our understanding of organizational knowledge.

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References

[1] Drucker, P F (1998) *Peter Drucker: on the profession of management*. Edited by Nan Stone. Harvard Business School Press.

[2] Kelloway, E K and Barling, J (2000) Knowledge work as organisation behaviour. *International journal of management reviews*, **2**(3), 287 – 304.

[3] Taylor, R (2002) *Britain's world of work: myths and realities*. Gloucestershire: ESRC Publications.

Computing model for estimating project indirect cost

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This paper presents a recent research on developing an alternative method for determining the total indirect cost of a project. Traditional methods of estimating indirect costs are reviewed first. A model that establishes the relationships between project factors and the ratio of indirect cost to direct cost is then introduced. The model is based on a back propagation neural network that is trained with a firm's historical cost data for a number of past projects. The model can be used by the firm for estimating the level of indirect cost for a given project. A comparison between regression models and neural networks shows that neural networks have better performance. The neural network model is potentially useful both for owners in setting project budgets and contractors in bid determination.

Keywords: project plan, cost estimate, indirect costs, computing model, neural network.

1. Introduction

Project indirect costs or site overheads are the costs incurred by a contractor for production support in undertaking a project. Indirect costs are not directly attributable to the performance of any particular item of work, but are required for running the project as a whole, including site management and supervision, site offices and shops, utilities and services, transport, safety and first aid etc. Like direct costs, indirect costs are essential costs for any firm completing the project at the level of quality required by project specifications. Since indirect costs may constitute a significant portion of the contract price, indirect costs have to be accurately estimated. While the amount of indirect costs depends on the project size measured by direct costs, the ratio of indirect cost to direct cost (or simply the indirect cost ratio) varies according to type of work, project conditions, and contract requirements.

Traditionally, contractors obtain a reasonable estimate of project indirect costs through a detailed and time-consuming analysis, based on the project plan and schedule and using a checklist. On the other hand, the short-cut method of fixing all of the contractor's overheads and profit as a percentage of the direct cost is prone to inaccuracy because of subjectivity. This paper presents a recent research on developing a alternative method for determining the level of total indirect cost for a project as represented by the indirect cost ratio. The research began with an investigation of general factors of a project that have an effect on indirect costs. Then, based on collected cost data for a number of past projects of a contractor, the research established the relationships between the identified factors and the indirect costs ratio by using quantitative models. The obtained models, which include regression equations and neural networks, were compared in prediction performance, in order to determine the best model, which can be used by the contractor for estimating the indirect cost ratio for a given project in determining the amount of total indirect cost and the project construction cost.

2. Factors influencing project indirect costs

While the customs, practices, and legal requirements of a country have an impact on indirect costs, a few attributes of a project potentially have influences on the indirect cost ratio. The size matters because many items of indirect cost exhibit economies of scale. The duration matters because many items of indirect costs depend on the project duration. The type of work, e.g. road, building, impacts on the level of supervision manpower required and transports and services. The project location, urban or rural, influences set-up and maintenance costs relating to offices and shops. The proportion of subcontracting influences the required communication efforts. The above factors were used as the input parameters of the proposed model for estimating the indirect cost ratio, while indirect cost ratio is the output parameter. While measurements of quantitative factors such as project duration, project size, and indirect cost ratio are obvious, qualitative or nominal attributes such as location and type of work were represented as binary variables.

3. Description of data

The cost data for this study were collected from a major construction contractor in Taiwan, consisting of 191 construction-only contracts that the firm bid for between March 2000 and February 2006. The projects ranged between 50 millions and 28 billions NT$ in size and between 5 months and 106 months in duration, covering a variety of types of work such as roads, buildings, tunnels, waterworks etc. The cost estimates for these projects have indirect cost ratios between 1.7% and 29.1%, with an average of 7.64% and standard deviation of 4.23%. Duration in months, location, type of work, total direct cost, proportion of subcontracting, as well as indirect cost ratio were identified for each project. Since total direct cost may not be a meaningful indicator of the scale and intensity of activity, the size of a project was represented by direct cost per month, i.e. total direct cost divided by project duration. The prepared project data were then tabulated and a statistical analysis was performed to find out correlations among these factors for the 191 projects.

There is a strong and positive correlation between project duration and indirect cost ratio. The negative but weak correlation between project size and indirect cost ratio may be explained by the fact that effects of economies of scale are mitigated by the more demanding quality systems for larger projects. Larger project size and more communication efforts may be the reason behind the positive correlation between proportion of subcontracting and indirect cost ratio. With respect to project location, each project was classified as in remote areas, in small towns, or in metropolitan areas. Concerning type of work, each project was classified as site preparation, building, road, waterworks, bridge, marine works, tunnel, or mass rapid transit. Analysis of variation concluded that the mean indirect cost ratios for the three location groups are not equal and that the mean indirect cost ratios for the eight type-of-work groups are not equal.

4. Description of models

Of the collected 191 projects, the 141 projects between March 2000 and July 2004 was used to build models for estimating indirect cost ratios. The remaining 50 projects from August 2004 to February 2006 were used as the testing sample to evaluate the accuracy of the built models. Two groups of models were constructed for a comparison. The first group consists of multiple regression equations built using combinations of factors from the identified five factors. While real numbers were used to measure the quantitative factors, binary variables were used to represent the location factor and the type-of-work factor, requiring 2 and 7, respectively. As a result, the maximum number of binary and real number independent variables in the regression models is 12.

Mean squared error (MSE) was used to measure the closeness of fit in constructing the models, while average percentage error was used to measure the prediction accuracy of a constructed model in testing against the applied indirect cost ratios [1]. The results show that the performance of a model improves with more factors being included. The three regression models with better performance were then selected for a comparison of performance with their neural network counterparts. Therefore, three neural networks were developed using the same input variables as the corresponding regression models. The BP algorithm was chosen for training thel networks. The number of hidden layer was fixed at one, while the number of hidden nodes was determined based on the ease of convergence in training and accuracy in testing. The number of hidden nodes finally selected is 23 for network A, 7 for network B, and 27 for network C. The number of training cycles used ranged between 20000 and 30000, along with a momentum of 0.9 and a learning rate of 0.7.

All the three neural networks achieve better closeness of fit after training than their regression counterparts, as indicated by a smaller MSE. Furthermore, all the three networks attain a better prediction accuracy, as indicated by a smaller average percentage error. The network with the best overall performance is network C, which includes all five factors as inputs, achieving an average prediction error of 32%. The neural networks perform better than the linear regression models because of the nonlinear nature of the stated estimating problem, which suits neural networks' mapping ability. We do not need to specify any exponential expression beforehand. We need only to present the data in a form exhibiting more non-linearity between input and output variables.

5. Conclusions

Based on the findings of this research, it appears that neural networks are good computing models for estimating project indirect cost. The presented methodology for model development is general and can be applied by contractors or owners in any country. From the viewpoint of practicality, the model can enhance the performance of cost estimating by providing a speedy estimate, and thus is potentially useful both for owners in setting a project budget and for contractors in cost estimating for bid decision or in checking the result of a detailed analysis. The model can be made a component of a comprehensive cost estimating system.

References

[1] Sonmez, R. and Rowings, J.E. (1998). "Construction labor productivity modeling with neural networks." Journal of Construction Engineering and Management, ASCE, 124(6), 498-504.

Revenue risk mitigation in BOT projects: A real options approach

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Effective risk management is essential for success in infrastructure project financing arrangements such as Build-Operate-Transfer (BOT). Both Sponsors and Lenders consider the revenue risk an extremely important factor when they assess a BOT project's feasibility. One potential strategy for mitigating the revenue risk is an insurance revenue guarantee, where a pool of insurance providers secures a minimum amount of revenue for a project. Even though the structure of this insurance guarantee may have a complex design to account for different insurer risk and financial exposure preferences, the value of the guarantee may be assessed by modeling it as a multiple-exercise real option. Specifically, the Least-Squares Monte Carlo method is employed to determine the fair value of this real option. A hypothetical case study illustrates its application and potential as an effective risk mitigation tool in BOT projects.

Keywords: Build/operate/transfer; Real Options; Monte Carlo method.

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1. BOT risks and revenue risk

During its life cycle, a BOT project is exposed to various risks that, if not mitigated, may financially distress sponsors and lenders [1], [2]. Therefore, before entering into contractual arrangements sponsors and lenders appraise the risks involved in the project [1], [3]. If they are not comfortable with the level of such risks and there are no available alternatives to mitigate them, they will likely withdraw from the project. In other words, sponsors and lenders finalize the BOT project "only if" the mitigation of the project's risks makes their investment profitable. Thus, risk management and risk mitigation play a central role in the successful realization of BOT infrastructure projects. One of the more significant risks of a BOT project is the revenue risk. The revenue risk is the adverse possibility that the project cash flows may not be sufficient to cover the project costs, to service the debt, and to generate the sponsors' expected investment rate of return. One possibility for mitigating the revenue risk is for a Government to guarantee a specific level of revenue for the Sponsor during a project's operations period. Hence, if the actual revenue generated by the project falls below the guaranteed amount, then the Government will finance the difference. The current methods to value this type of guarantee makes use of a European option framework [2], [4]. In fact, it is possible to employ these techniques to value the revenue guarantee for some particular operational years, i.e. partial coverage. However, the shortcoming of this approach is that the guaranteed party must specify beforehand the years in which they want to exercise the revenue guarantee. Therefore, relevant information about the revenue guarantee shortfalls that eventually will be revealed during the operational phase cannot be used to empower the exercise strategy of the guaranteed party. On the other hand, it is possible to overcome the lack of decision flexibility by arranging a full risk coverage revenue guarantee that protects the guaranteed party against the revenue shortfalls over all operational years. However, this arrangement will result in a costly long-term commitment for the guarantor. Unlike the abovementioned revenue guarantee arrangements that show "static" decision features, the new frameset of "dynamic" revenue guarantees proposed in this paper permits the guaranteed party to decide on the "spot", i.e. during the operational phase, where to redeem the revenue guarantee. Accordingly, the guaranteed party can take full advantage of the relevant information that will be revealed over the operational phase to make the best exercise decision.

2. Dynamic revenue guarantee

A general revenue guarantee is a contract in which one party promises the other party to pay the revenue shortfall (K - X) relative to a period of time Δt, that is the difference between the minimum guaranteed net revenue, K, and the net revenue, X, accumulated in Δt. The contractual cumulative period Δt is a project financial auditing interval, which typically occurs on a quarterly, semi-annual or annual basis. This type of scheme is akin to a financial put option.

Accordingly, the "dynamic" guarantee revenue can be framed as a multi-exercise put option exercisable M times in discrete points over the operational period. The payoff function of such option is represented by

$$\Pi = \max\left(K - X, 0\right) \quad (1)$$

where K, the guaranteed net revenue, is the option strike price and X, the net revenue, is the underlying stochastic process. The computational tool used to value this multiple exercise option is the Multi-Least-Square Monte Carlo method [5], which is obtained by extending the American-option valuation method proposed by Longstaff and Schwartz [6] to multiple exercise dimensions.

3. Multi-guarantor revenue guarantee

As illustrated previously, the current valuation tools only have the capacity to determine the value of a limited set of "static" revenue guarantee configurations. Moreover, the available tools also presume that a single guarantor, which is most likely the Government, will underwrite the guarantee. This circumstance limits the flexibility afforded to the Public and Private sectors to fashion mitigation strategies that match their financial positions and risk tolerances. A more general and effective approach is to offer a "dynamic" revenue guarantee that may be underwritten by parties other than the Government. As a form of revenue "insurance", the underwriters of these products might include any number of the parties normally involved in BOT projects, including international financial institutions (e.g. IRBD, IFC, EIB), export credit agencies (e.g. EXIM, OPIC, EDGC) and private insurance companies (e.g. AIG, Lloyds, Swiss RE, Zurich-American). The key characteristic of this contract is that it facilitates the pooling of project revenue insurers by "accommodating" insurer financial and risk preferences. In fact, this "accommodation" is achieved by providing a pre-agreed priority payment sequence for the claimed net revenue shortfalls. The following illustrative case study will clarify the mechanics and risk mitigation strategies of this "dynamic" revenue risk mitigation contract.

4. Illustrative case study

The case study examines a Greenfield BOT toll road project harmed by a significant project revenue risk. This BOT project is assumed to have a 2-year construction phase and a 30-year operational phase. The base case yields a net present value, NPV, of roughly \$4.3 million and an internal rate of return, IRR, of 19.7%. A Monte Carlo risk analysis on the net revenue by considering the traffic volume as the only risk variable [2] generated an equity cash flow NPV distribution with an expected NPV of \$4.3 million and probability that NPV is negative of 36.3%. With such a high likelihood that the project has a negative NPV, Sponsors may decide to abandon the project. In fact, unless the revenue risk is mitigated to a level that does not endanger the profitability of the project, the project is not financially feasible to the Sponsors. Accordingly, Sponsors may consider ensuring a minimum equity cash flow to preserve the project's profitability. Such a minimum ECF level can be represented by the minimum annual equity cash flow, K, that generates a Sponsor's rate of return as much as the cost of equity, i.e. 15%. Eventually, the value of K is estimated as high as \$6.5 million. In this case study, the pool of insurers comprises one senior guarantor, Insurer A, and two junior guarantors, Insurers B and C. The "seniority" among the insurers is established by a pre-agreed priority payment sequence. Furthermore, it is assumed that each insurer is only responsible for its own payment, that is no insurer is liable if another insurer is in default. The insurance guarantee can be modeled as a multiple-exercise put option with payoff function (1). Accordingly, the fair value of the revenue guarantee for different numbers of allowed exercise rights can be computed. Sponsors can use the spectrum of different contract values to choose the most suitable revenue risk coverage for their mitigation strategy, which may include a portfolio of other mitigation tools.

References

[1] Yescombe, E. R. (2002). *Principles of Project Finance*, Academic Press, San Diego, CA.

[2] Dailami, M., Lipkovich, I., and Van Dyck, J. (1999). "INFRISK: A Computer Simulation Approach to Risk Management in Infrastructure Project Finance Transactions." *Paper No. 2083*, World Bank, Washington, D.C.

[3] Hoffman, S., L. (2001). *The Law & Business of International Project Finance*, Transnational Publishers, Incorporated, Ardsley, New York.

[4] Irwin, T. (2003). "Public Money for Private Infrastructure." *Paper No. 26601*, World Bank, Washington, D.C.

[5] Chiara, N. (2006). "Real Options Methods for Improving Economic Risk Management in Infrastructure Project Finance" *PhD Dissertation*, Columbia University, New York.

[6] Longstaff, F. A., and Schwartz, E. S. (2001). "Valuing american options by simulation: A simple least-squares approach." *Review of Financial Studies*, 14(1),113-147

Student housing Italy: typology and technology toward sustainability

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The Italy's educational system has always focused mostly on developing and delivering efficient teaching models. With this aim, the provision of facilities like student residences has almost been a very secondary concern. The result of this choice is today's chronic deficit of student accommodation and the insufficient attention given to architectural models that should meet the complex series of requirements specific to the university residences. The proposed article analyze the Italian context and the different legislative provisions. Moreover some cases of study will be presented.

Keywords: Student housing, regulations, current trend, sustainability.

1. The Student housing regulation

The law n. 338/2000 [1] and its "put into practice" ordinances, has signed an important improvement compared with past legislation: it, in fact, divides the student housing promoters and builders from those involved into "subsidize housing" on a financial, technical and prescriptive level. The "put into practice" ordinances of Law n. 338/2000 could be considered as the most important legislative innovation. D.M. n° 118 (9/07/01) [2], in particular, contains:

1) the minimal dimensional and qualitative standard (Attachment A);
2) the guidelines for technical and economical parameters (Attachment B).

The compulsory instructions are divided into two categories: interventions that can avoid prescriptions;

a) A1, demolition of architectural feature that denies access to the handicapped;
b) A2, adaptation of current dispositions under sanitary and security aspects (such as asbestos and injurious to the health materials removal);
c) A3, extraordinary maintenance; interventions subjected to prescriptions:
d) A4, restorations, building and urban restructuring;
e) B, new constructions or extension of student housing, including the acquisition of the necessary areas;
f) C, purchase of buildings to be destined to student housing, including also the interventions, described by the A letter.

2. Current trends in student housing

Universities and their supporting structure have a peculiar relation with the urban context that give important indications on the current trends, that student housing has taken in the latest years due to changes in the Italian social and economical reality. the common settlement model applied is that of a student housing within historical context or central areas. This model derives from historical transformations that characterised the birth of universities, especially those with a classical kind.

In the latest years municipalities and regions financed the restoration of public historical buildings in the city centres using national funds. This approach caused the transformation of building with a different function into student housing defining a new model for the collective building serving the entire university community: in such cases the student houses is structured as a diffuse lodgings' system surrounding the university, in close relation with the city and university life.

In other cases both universities and student houses are located in demi-suburban areas defining another model commonly adopted by scientific poles. In these cases the new university complexes, following urban choices made in seventies, were located in areas destined to city expansions, in the light of a future enlargement of the complex with student service buildings.

The last model analysed is related to student housing located in peripheral areas and in service less neighbourhoods. This choice characterises the contemporary interventions' approach on weak city areas. Universities and student houses have the task of brightening up neighbourhoods, and supporting the birth of services and cultural and recreative activities, in a long time.

3. Type and distribution [3]

Traditional residential housing often derives from typological processes that could not be recognised in student housing. The difficulty in defining a typological development mainly depends on:

a) a strict influence of traditional housing and/or hotel types;

b) changes in cultural models;

c) changes in didactic methodologies and related structures in the same universities.

However there are some recurrent types: line apartments houses, and tower houses.

The common distribution of a student housing is in many cases a corridor distributed the lodgings in both historical or new buildings converted into student housing. A variant is represented by the balcony, that often becomes a panoramic external access way. Another variant is the compact distributing space of the "central nucleus", that involves a limited surface of both the serving areas and served lodgings in comparison with the corridor variant.

4. The architectural organism [3]

The student residential areas structured as mini-flats or flats are of particular interest because they involves the definition of "mini-flat cell" and "flat cell" for student housing. The mini-flat for one/two students presents an open space with bed-seat, the study-seat, the bathroom and a small cooking corner (often substituted with a room). The flat has a different spatial organization in comparison with the traditional housing aggregations: each bedroom has its internal and autonomous bathroom; there is a common residential space for cooking, eating and socializing. When a traditional residential building has been converted into student housing, bedrooms do not include services, while bathrooms, dining rooms and kitchens are shared.

5. Student housing and sustainability

5.1 Student housing at Reggio Calabria [3]

The student housing has been designed to complete University structures with a scientific and technological kind. The entire complex presents a two-levels equipped plateaux with a rectangular grid.

The technological solution adopted are very interesting: the idea of creating a sustainable building has determined the project of different constructive parts, that depend on both the orientation and the function within the residential complex. The "garden roof" is used for covering the plateaux and the collective services: vegetation has a specific agricultural character with local plants. The climatic buildings' control is obtained with the integration of traditional and "passive" collaborative installations.

5.2 Student housing at Monte Cengio-Padova [3]

In seventies the University of Padova started a decentring program for the university student housing, in order to integrate students with suburban areas inhabitants. The complex known as Monte Cengio was purchased by the ex University Institution, and several building enterprises realised the expansion of the area. The experimental social program for the area provides that the students shall integrate with suburban areas inhabitants. Therefore the collective areas are located at the buildings' ground floors: an internet café, a meeting room (building A) and a study room (building B). Even in this case the student housings use sustainable techniques and technologies for energy savings. The entire complex is served by an urban teleheating grid connected with the general thermic boiler. A presence detector system and a long distance flats' controlling system expand the heat saving: all the flats devices are automatically switched off when users are absent. The heating system integrated traditional radiators and floor radiant panels with low operating temperatures. The residential cell is structured as 2/4 students flat including two bedrooms (single or doubles) with internal bathroom, that overlook the dining room/kitchen. Each cell measures 45 square metres.

References

[1] D.M. 9th May 2001, n° 116: Actions and methodologies for project presentation, and for the assignment of funds devoted to university student housing, included in Law 14/11/2000 n. 338 and Law 23/12/2000, n. 388. Published on *Gazzetta Ufficiale* n° 274 (23rd November 2000).

[2] D.M. 9th May 2001, n° 118: Minimal dimensional and qualitative standards, guidelines, technical and economical parameters for university student housing, included in Law 14/11/2000 n. 338 and Law 23/12/2000, n. 388. Published on *Gazzetta Ufficiale* n° 274 (23rd November 2000).

[3] Chiarantoni C. (2005), Doctorate thesis, La residenza universitaria. La storia e le funzioni. Analisi critica della situazione italiana. Il ruolo del progetto tra norma e tecnologia nella definizione delle nuove tendenze, *Department of Architecture and Urbanism, Faculty of Engineering, Politecnico of Bari.*

An ontology for the knowledge management of earthen construction: the earth mix design domain

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The theory of Knowledge Management (KM) studies and provides methodologies and tools capable of managing it, through an innovative approach. It is recognized that knowledge dissemination and decentralization are the most important key points to improving the success of the proper use of a specific technique. The heritage of earthen architecture is particularly subjected above all to dispersion and losing of implicit knowledge: in this field KM can be a complex paradigm, because all the tacit knowledge consists of that kind of informal technical skills captured in the term "know-how". Existent explicit knowledge is, instead, disorganized and dispersed. Moreover, knowledge has to be shared and disseminated, in order to be truly effective and profitable for the advancement of the research in the field. The goal of the work presented is the implementation of advanced methodologies for collection, management and sharing of knowledge on earthen building technologies through the application of ontology-based tools. The implemented tool is expected to be a valuable support for the analysis and the management of different sources of domain knowledge, and to enable its reuse and sharing among the operators involved in the construction process.

Keywords: Knowledge management, ontology, architectural heritage.

1. Introduction

This paper is focussed on the application of ontology-based tools to the management of knowledge of earthen construction techniques. Earthen architecture is characterized by a high level of technical variability and integration into its geographical and technical environments. The Earthen architecture heritage is in danger for two kinds of reasons: first, it is particularly exposed to deterioration, lack of maintenance and progressive abandonment; second, it is subjected to the dispersion and loss of implicit knowledge. The second issue is certainly the most dangerous. Recently the growth of awareness regarding the risk of losing this kind of knowledge has contributed to the awakening of a consciousness and to the beginning of a debate.

2. Environment of the research

Though earthen building techniques are characterised by high performances, environmental sustainability and versatility of applications there are some elements that hurdle the diffusion of this building technique:

- the information specific to the field of conservation of earthen architecture is lacking in a number of areas. Nevertheless, a great deal of information exists in grey literature that is not readily accessible or reported on;
- for each specific research subject, it will be necessary to do a preliminary cross-disciplinary desk assessment and synthesis. Identified missing pieces will have to be adopted/adapted from other disciplines or generated specifically as a result of a specific research effort;
- the access to existing data in the field of earthen architecture and its conservation is severely limited due to the lack of centralized databases, online catalogues meeting international library standards, and the like;
- the results of the research should be made broadly accessible, especially through the development of appropriate diagnostic methods and analytical tools.

The lack of applications is strictly connected to the fundamental issue of managing and organizing the existent scientific knowledge and the local and tacit technical knowledge, and to integrate it with national and international references from other disciplines. The design of new earthen constructions requires a deep knowledge of physical and mechanical characteristics of the building material and in particular the phase of selection of the appropriate earth (mix design) is decisive in order to ensure the production of high-quality buildings.

3. The ontology of mix design

In recent years the development of ontology is playing a key role in knowledge management. "Ontology" is the name given to a structure of knowledge, used as a means of knowledge sharing within a community. An ontology is a "data skeleton" that can be developed for a variety of data-based and knowledge-based systems. It consists of a collection of concepts (or classes) and relationships between them. Generally, each concept is represented by a favoured term, word or phrase. The ontology might include principle synonyms (abbreviations, common misspellings) for each term. It could contain only a single type of relationship between terms; e.g., a "kind-of" relationship, such as "pisé and adobes are kinds of earthen building techniques." However, ontologies can represent other relationships (e.g., part-of, precedes-in-process, reports-to). Further, terms in ontologies can have qualifying attributes, and ontologies can include restraints ("rules") on values for terms. So, an ontology includes basic knowledge relationships that a variety of types of knowledge applications might use. For humans, ontologies enable better access to information and promote shared understanding. For computers, ontologies facilitate comprehension of information and more extensive processing. The methodology adopted for the ontology development comprises the following phases:

1. Identification of the research topic. The preliminary step is characterised by the identification of the domain through a complete and accurate definition of the "boundaries" of the topic selected.
2. Review of existing ontologies/taxonomies. The use of ontologies can provide a significant advancement of knowledge among different communities. For this reason, it is important to evaluate the opportunity of reviewing existing ontologies or taxonomies, in order to reuse the related knowledge.
3. Identification of sources of domain knowledge. This step entailed the gathering of different typologies of knowledge, information and data.
4. Elaboration of information. The different types of information have been selected and represented inside the ontology through the construction of a taxonomic structure that contains the concepts used for the domain modelling.
5. The ontological representation of concepts. This step is about the definition of the relationships among classes and the properties that characterise each class.
6. Elaboration of the knowledge base. The ontology is populated with examples that are concrete instances of the information and that constitute a true knowledge base.

The ontology of mix design aims at organising a double-sided field of knowledge representation. On the one hand it aims at reorganising the fragmented and dispersed domain of knowledge pertaining to the mix design of adobes, using therefore "descriptive" information that are able to describe the topic from different point of view (elements that constitute the material, tools, actors, etc); on the other hand the ontology intends to support the decisional actions needed for the definition of the appropriate mix of earth for the production of adobes, involving "operational" knowledge, as such necessary for the development of procedures and tasks. The top level classes and the main semantic areas that compose the ontology are "Materials", "Tools", "Actors", "Conceptual elements", "Protocol elements". The class "Materials" includes the description of natural or manufactured materials, used or produced by the procedures. The class "Tools" consists of the physical objects created by men, necessary for the development of the procedures. The class "Actors" includes people that perform intentional actions on their own responsibility in the sector of mix design selection procedures. The class "Conceptual elements" contains all the immaterial entities that are produced by intellectual activities. Finally the class "Protocol elements" contains all the knowledge necessary for the development of the activities, so that it can be used as an operative tool for supporting decisions.

4. Application of the ontology

The ontology can have different usability levels: it can be accessed using a problem-solving method to answer questions and solve problems regarding the domain. It can be used for supporting decision when approaching new building projects, suggesting the best practice in a particular area with a definite kind of earth and, trough the system of queries, answering questions of the researcher, the architect, the conservation scientist and the end users. Furthermore, one of the main motivation behind ontologies is that they allow for sharing and reuse of knowledge bodies in computational form: a flexible access to a "shared workspace", could be represented by a shared server on internet which supports document upload, event notification, group management and much more. To access a workspace, group-members only need a standard Web browser and a login-name and password.

References

[1] Balderrama A.A. (2001) *The Conservation of Earthen Architecture*, The GCI Newsletter, Vol.16
[2] Brooking A. (1999) *Corporate Memory, strategies for knowledge management*, Thomson Business Press.
[3] Fensel D. (2000) *Ontologies: Silver Bullet for Knowledge Management and Electronic Commerce*, Springer-Verlag. Berlin.
[4] Noy N. F., McGuinness D. L. (2001) *Ontology Development 101: A Guide to Creating Your First Ontology*, Stanford University. Stanford.
[5] Uschold M., Gruninger M. (1996) *Ontologies: Principles, Methods and Application,* Knowledge Engineering Review, Vol. 11, No. 2, pp.93-115.

Waste minimisation in the U.K. construction industry

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Waste minimisation is one of the construction industry responses to the sustainable construction agenda. The use of waste minimisation and management strategies is believed to have key economic benefits as well as fundamental environmental benefits. The implementation of waste minimisation and management in the construction industry is governed in many ways by the perceptions of the practitioners. A survey of consultants and contractors reveals the waste management measures currently implemented in the UK and the perceived effectiveness of these measures. The survey, building on current waste management research, investigates the benefits of waste management and the barriers to its implementation..

Keywords: Waste minimisation, waste management, industry practices.

1. Waste minimisation in construction procurement

Sustainable development is concerned with achieving an effective balance between economic progress and environmental conservation [1]. The construction industry is responsible for the production of the necessary facilities and infrastructure required for economic growth. The concept of sustainable development emerged from a general agreement that 'uncontrolled exploitation of natural resources is not beneficial to humankind in the long term' [2]. The construction industry is a major consumer of natural resources, and the wastage rates of materials are significant averaging 9% (by weight) [3].

Traditionally waste management referred solely to the management of waste once it had been produced. This concept of waste management does not directly address the issue of reducing or minimising waste at source. '*Today, it is accepted that the single most effective way of dealing with any solid waste is not to create it in the first place*' [4]. Waste minimisation is also concerned with improving the quality of waste produced in order to facilitate its reuse, recycling or recovery [5]. An assessment of the current role of waste minimisation in the UK construction industry is warranted in order to establish the extent to which the industry has adopted the principles of waste minimisation in response to environmental legislation and the growing concerns of society as a whole on the environmental impacts of anthropogenic activities such as construction.

2. The frequency and effectiveness of waste management measures

A survey of waste management practices in the UK was undertaken to establish the perception of practitioners in the construction industry. The survey aimed to establish which waste minimisation measures were being implemented and which were considered the most effective. The waste management measures were grouped into three categories: Design; Procurement; and Construction. The top five most effective waste minimisation measures were perceived to be:

1) Ensuring materials are properly stored and protected on site

2) Incorporating the use of prefabricated components in design

3) Inducting site operatives in proper materials handling and practical waste minimisation measures

4) Active participation of main contractor in design process

5) Ensuring materials are supplied with suitable packaging to prevent damage during transport and subsequent handling

The waste minimisation measures used most frequently are primarily concerned with the procurement of materials and their subsequent handling and storage on site and come under the remit of the main contractor, subcontractors and suppliers. Design management measures are noticeably absent from this list, the highest ranking design measure being 'managing the design to prevent over specification of materials' in 8th place

3. Benefits of and barriers to waste minimisation

A list of benefits and barriers of waste minimisation were derived from the survey carried out by Shen & Tam [6]. The survey respondents ranked the benefits of waste management (table 2). There was general agreement that all the established benefits made a significant contribution. The top benefit of waste management was a reduction in waste disposal costs. This is a significant factor in the motivation to implement waste management measures.

The lack of local infrastructure for recycling (J) is perceived to be the most significant of the 14 barriers to implementing waste minimisation measures followed in turn, by the lack of participant awareness of waste issues (G) and the lack of support from subcontractors (D). All barriers exhibited mean values above 1 indicating that they all exist to some extent in the construction industry, however the least significant barrier is that of the change in organisation structure and / or policies that can be associated with the implementation of waste minimisation measures. The association of increase in management and operational costs (K) was perceived to be of only moderate significance with a mean value of 2.00 and was ranked 8th. This contrasts with the aforementioned study conducted by Shen and Tam [6], in which this barrier was found to be the most significant of 13 barriers to implementing environmental management put to respondents. However the lack of trained staff and expertise, and the lack of subcontractor cooperation also featured highly in their study drawing some parallels with the findings here

4. Conclusion

It is evident that all of the waste minimisation measures encountered in the literature review are being implemented in construction projects, however they are implemented with varying degrees of frequency and there appears to be substantial scope for increasing their implementation. The most frequently employed waste minimisation measures are concerned with the procurement and subsequent delivery and handling of materials. Potentially more effective measures implemented during the design process are employed less frequently. Although all parties are regarded as having a share of the responsibility for waste minimisation in a construction project, it is the main contractor that is considered to shoulder the greatest responsibility. The main contractor is also considered to be in the best position to implement waste minimisation measures and Design and Build to be the procurement method which best facilitates the implementation of waste minimisation measures. These results indicate that there a general reliance on the main contractor to implement waste minimisation measures.

There is unanimous agreement among the respondents that waste minimisation measures are indeed cost effective. Waste minimisation measures contribute to all of the listed benefits derived from the literature review, the most significant contribution being in the form of reduced costs of waste disposal, increased compliance with environmental legislation and enhanced protection of the environment. All of the listed barriers to implementing waste minimisation measures exist however the most significant are deemed to be the lack of local infrastructure for recycling, the lack of participant awareness of waste issues, and the lack of support from subcontractors.

References

[1] Langston, C. and Ding, G.K.C. (2001) Sustainable Practices in the Built Environment, 2nd Edn, Butterworth-Heinemann, Oxford.

[2] Hill, R C and Bowen, P A (1997) Sustainable construction: principles and a framework for attainment. Construction Management and Economics, 15, 223-239

[3] Bossink, B A G and Brouwers, H J H (1996) Construction waste: quantification and source evaluation. Journal of Construction Engineering and Management, 122(1), 55-60.

[4] Gavilan, R M and Bernold, L E (1994) Source evaluation of solid waste in building construction. Journal of Construction Engineering and Management, 120(3), 536-552.

[5] Cheeseman, K (2002) Waste minimisation – a practical guideLondon: Chadwick House Publishing

[6] Shen, L Y and Tam, V W Y (2002) Implementation of environmental management in the Hong Kong construction industry. International Journal of Project Management, 20, 535-543.

Local operativeness within global strategy for managing sustainable construction

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When facing the issue of sustainability, the problem of considering the local as well the global scale of thinking and acting significantly arises. This invites reasoning in terms of the approach to be used, and this paper proposes to use a two-level approach, facing the local with the global in mind. The two main characteristics of the approach, which are considered more productive in terms of sustainability, are those of being holistic and of a 'learning-by-doing' type. The two levels, operative and strategic, of such an approach are then analyzed through three case studies.

Keywords: global, local, strategy, action, existing buildings.

1. Sustainability in the construction field

Sustainability is a very broad concept, of general interest and almost universally accepted, but not univocally defined, thus still remaining rather vague [1]. However, beyond the conceptual meaning, one of the most important problems concerning sustainability is how to put it in practice, how to configure and then implement sustainable actions, and how to measure their effectiveness.

Although we started to talk of sustainability in buildings and constructions more recently than in other fields, many interesting results have been achieved, both on theoretical and practical levels. Nevertheless, we must recognize two weak points of all our efforts: (i) we are still unable to overcome the problematic aspects of sustainability in practice efficaciously; and (ii) we are not tangibly contributing to real improvement of the environment, the people and the economy. Thus, I think this situation should make us reflect in terms of improving the approach we use towards sustainability in the construction field, aiming at being more successful in acting at the local scale of a sustainable development and more productive in contributing to the global scale of sustainability.

2. A two-level approach

I think that the two main characteristics of a more productive approach can reside in being holistic and of a *learning-by-doing* type. The holistic characteristic can allow us to respect the complexity of real situations, in particular to consider the many interrelated aspects of sustainability, trying to avoid prevalence of one over the others; while learning-by-doing can help us to mature the right expertise to include in the process all the actors and necessary actions to define a real sustainable practice. Thus, the approach can be considered two-level, favoring operativeness required for acting at the local scale on the one hand, and supplying a strategy necessary for contributing to the global scale on the other. Implementing different and various sustainable actions, be it at the local level, as long as they are made within a global sustainability strategy, seems to me the only way to be successful, since the shift between the two levels of approach can continuously stimulate the ability of producing innovation, which is considered indispensable for sustainability [2].

3. The case studies

The two levels, operative and strategic, of the proposed approach are analyzed through three case studies, referring to existing building stock in a city, and considering to retrofit it in a sustainable way in order to effectively contribute to sustainability of the built environment.

The three cities under study are all in the Apulia Region, in South Italy, Taranto, one of the six provincial capitals of the region, on the Ionian Sea, Bari, the regional capital, on the Adriatic Sea, and Gioa del Colle, in the province of Bari, in between Taranto and Bari. The three cities are different in size, population, economy, and municipal government; however, the physical and social aspects of the public social housing building stock considered in the study present analogies allowing comparison between the three different situations.

In all the three cases, the final purpose of the study was to suggest to the public actor, owner and manager of the social housing estate, a global strategy to retrofit buildings and re-qualify urban spaces and infrastructures in a sustainable way, within which implementing different actions in the local context. To do this, a basic premise of the work carried out was always to treat as interrelated both the physical and social aspects of the case studies, which were then investigated from a technical as well as a societal point of view, in order to respect the complexity of real situations and to guarantee a sustainable character to the suggested strategy and actions. In this light, actors involved in the process are very important and some attention must be posed to the methodology used for eliciting various kinds of knowledge, useful for a multi-faceted evaluation of the present situation and also for recognizing the features of sustainability of the strategy and actions to be proposed.

At the end of the process, the research team used the knowledge derived from documents and on-site surveys, as well as the knowledge elicited from the different actors, to design a strategy and related actions to be implemented in each local context.

4. Managing sustainable construction

Like any other activity today, construction management too must be re-interpreted in the light of sustainability; and this should be done in the two dimensions, the substantive and the procedural one, in which sustainability is to be thought of as acting as an integrating concept [3].

In order to change the usual construction management activity, learning is a key concept, following the universal principle that learning must precede change; however for creation of change, more than traditional learning is required, and new learning ability is necessary to enhance an action which makes change effective [4]. New learning ability can be gained in several ways, however two training activities seem deserve special attention: learning from failures and learning collectively.

When carrying out experimentation on the three case studies, what the research team did was to bear the substantive as well as the procedural dimension of sustainability in mind, this corresponding to the two levels of the proposed approach, the holistic one and learning-by-doing. Moreover, a peculiarity of the experimentation was to activate a learning process, trying to overcome traditional learning and knowledge acquisition and focusing on how to collect and use multiple forms of knowledge. In this light, two significant lessons emerged from the experimentation: on the one side, the decision-makers have to adapt their decision making process to the specific case and context in a way that is accepted by the actors involved in the process; on the other side, the decision-makers should be productively supported by better tools to measure sustainable development, particularly at an intermediate level, like that of a municipality.

Thus, it seems that an operational perspective of the research presented here may be the design of a DSS, based on the multiple forms of collected knowledge. We imagine that the end-user of the DSS is the public decision-maker and the main aim is to facilitate the decision making activity, by including an objective description of the reality under study, through data, information, expert knowledge and skills, as well as a subjective description coming from any kind of knowledge, expertise, and ability, so to favor a better representation and understanding of the complex reality. Major attention must be posed to the cognitive mapping approach used in the system for building the knowledge base.

4. Conclusions

The final outcome of the study presented in this paper, should be considered that of having brought to light some features of a sustainable process for managing existing buildings and the built environment, which go beyond technical solutions and local applications; in conclusion, reaching a strategy that seems to ensure shareability and durability, and then sustainability, to development implementation. The key point of local vs global development posed by sustainability to each activity, was tested in relation to the construction management activity through three case studies that could be now considered as benchmarks of the procedure used; the case studies enabled us to experiment a new, two-level, approach, as well as different methods of knowledge acquisition from multiple actors involved in the process.

References

[1] Keiner M. (2004) Re-emphasizing sustainable development – The concept of 'evolutionability'. On living chances, equity, and good heritage. *Environment, Development and Sustainability*, 6, 379-392.

[2] Johnson K., Hays C., Center H, Daley C. (2004) Building capacity and sustainable prevention innovations: a sustainability planning model. *Evaluation and Program Planning*, 27, 135–149.

[3] Robinson J. (2004) Squaring the circle? Some thoughts on the idea of sustainable development. *Ecological Economics*, 48, 369-384.

[4] Lick D.W. (2006) A new perspective on organizational learning: Creating learning teams. *Evaluation and Program Planning*, 29, 88-96.

Industrial techniques for building maintenance: Looking for a semi scientific approach

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This paper presents the initial results of research into techniques that may be transferred from the industrial maintenance to the building maintenance. In the first part, with reference to the scientific literature and local features of European and particularly Italian building stock, the authors identify the relevant features of the whole building system and its consequent maintenance activity. The second part concentrates on understanding the main industrial techniques for maintenance management. The aim of this research is to select the most appropriate technique for building maintenance and to suggest fitting applications.

Keywords: Building maintenance, industrial maintenance, building performance.

Real estate industry, construction and real estate services, is one of the biggest European industrial sectors, in terms of total turnover (13.6% GDP EU 25) and employees (14.6 millions of people) [2]. The Italian construction industry, assessed in less than 9.0% GDP, represents the most dynamic industrial sector. Maintenance of existing building is the biggest share of construction investment value in Italy. The built environment is one of the main actors in the environmental issue, because of land use, non renewable resources consumption, greenhouse gas emission, air-soil-water pollution. The building sector is responsible for about 40% of Europe's total primary energy consumption [4]. The EU 2002/91/CE Directive on energy performance of building is moving toward environmentally friendly buildings, including in its target large existing building (>1000sqm) as soon as they undergo significant maintenance actions. The maintenance of existing building stock could play a relevant role in reducing the energy consumption. The buildings are affected by the contributions of different and high technological industrial sectors. Product evolutions find their own and immediate way in the building automation. A more holistic vision would set building automation joint to sustainability. Building is supposed to become "a machine for living" and as a machine is expected to work, to cost, to be maintenanced.

1. Building maintenance and its specificities

1.1 Building maintenance in Italy: features.

Recent concerns about building maintenance in Italy find their origins in the combination of numerous factors:

- Building stock age.
- Demand for technological adjustment.
- Property & real estate market.
- Container-content relationship.
- Legislative framework evolution.

1.2 Building consumption

Even if buildings are static in space, they are dynamic over the time; once used, or better once designed, a building is supposed to undergo a progressive consumption. Since the building value is linked to the quality of services offered, plus a combination of productive factors, maintenance actions become necessary to maintain it over the time.
Physical building consumption, due to the regular use of building, could be accelerated in the main part of case by some pathological features. These features are to be found in faulty design and construction process. Faulty design has a relevant consequence on the building consumption and its consequent maintenance [5]. The wrong evaluation of a certain building component consumption in a certain environment is the main cause of the accelerated component consumption. This consideration adds a further complexity to design the building maintenance: the interactions of the building and the surrounding environment and the behaviour as a system of this whole.
The main part of building components are not bistable and affected by a difficulty in discovering their failure state. The effects of faulty design or not correct use will be noted in a relevant range of time.
The ignorance in the degradation process of building materials is also increased by the prototype feature of a building, which makes each project unique in itself and at least similar to the other.

1.3 Building performance and building maintenance performance.

Building performance could be defined as the ability to fulfil the functions of a building's intended use.

Over the last years, there has been, in a way, a gradual understanding of the importance of buildings as an enabler resource to increase the productivity of employees, and in the other way the increasing thinking of building as an income producer in itself. In other words: tenants & owners want their building to be attractive, long lasting, efficient (adaptive, energy efficient, habitable and secure). According to the concept of building as an enabler resource, if the building performance decreases over time, building maintenance is a necessary investment. As investment, building maintenance should let investors know its rate of return, or in other words building performance should be measured in order at first to know the quantity of necessary maintenance actions, and then their efficiency.
This way moves the issue of measuring the building maintenance performance to measuring the building performance.
The assessment of building performance requires a reference standards to be defined. Defining a reference standard for building performance has to start from the awareness that it will not be absolute, but that it is supposed to evolve. Standards could easily fit commercial building but could difficulty be applied to the residential building stock, due to the not easy calculation of the "amount of user perceived discomfort", because of incorrect maintenance.

2. Industrial techniques for building maintenance

The potential transfer of maintenance knowledge, developed in the industrial production to the building maintenance activities relays two relevant categories of contributions. All those studies, developed on the logistical features of maintenance, focused on the maintenance strategy, optimizing and programming the maintenance actions and resources belong to the former. The studies, whose aim is to define an appropriate modelling to forecast the behaviour in time of the components, in order to manage, as much as possible in the design phase already, the probability of failure event, belong to the latter.
Based on a survey of the most relevant techniques developed by the industrial production or already applied in, the authors have tried to identify those, which could more easily fit the specificities of building maintenance.

2.1 Industrial maintenance management techniques.

Based on a survey of those techniques developed by the industrial production, which seem more versatile and have already been applied or could be suggested for their application in the building maintenance process, the following have been selected and analyzed: LCCA, FMEA, RBD, Markov Analysis, Neural Network and Fuzzy Logic [6].

2.2 The correlation matrix.

The correlation matrix has been developed on the basis of the features underlined by the previous analysis. Its intent is to provide a semi-scientific approach to the selection of those techniques more suitable to building maintenance, knowing in advance that it could be susceptible to evolution but well focused on the highlights of the issue.

Conclusion

The application of those techniques developed in the industrial production (LCCA, FMEA, RDB, Markov Analysis) is limited, if referred to the building maintenance, but they could be used as support tool to validate the design process. Soft computing techniques (Neural Networks and Fuzzy Logic) have not been developed in the industrial production but have already been used in this field. Those techniques are more versatile and adaptive to building process evolution, they could be used in monitoring maintenance activity, acting as decision makers support tool.

References

[1] Costantino, N and Dibari, G. (2006) Building maintenance vs. Industrial maintenance, Proceedings of Maintenance Management 2006, Sorrento April 2006
[2] Scenari Immobiliari-Dtz Research. (2005). Real Value in Europe, Milan.
[3]ECOFYS. (2004). Mitigation of CO^2 emission from the building stock, Cologne.
[4] Douglas, J. (1996). Building performance and its relevance to facilities management in Facilities, Vol. 14, N° 03/04. 23-32.
[5] Al-Hammad, A. and Assaf, S. (1997). The effect of faulty design on building maintenance in Journal of Quality in Maintenance Engineering, Vol.3, n.1. 29-39.
[6] Fedele, L.; Furlanetto, L.; Saccardi, D. (2004). Progettare e gestire la manutenzione, McGraw-Hill, Milan.

Reasons for the lack of competitiveness of Portuguese construction industry

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The last few years have confirmed what was mostly feared: Portuguese construction industry suffers from a chronic disease - the lack of competitiveness. Symptoms have long been recognised in several construction projects: frequent delays, cost overruns, deficient safety, absent quality. In order to assess and to make clear the construction delays problem a PhD survey was administered. It has the following mains components: (1)) to inquire to Portuguese construction stakeholders on the causes and background reasons for project delays following from their experience in recent projects; (2) to establish possible paths to solve the problem.

Keywords: Portuguese construction competitiveness, construction delays, survey.

1. Construction delays consequences

The consequences of a time overrun are almost always serious and hard to resolve. Failure to meet deadlines represents financial losses to the users and, more often than not, it has a negative impact on the profitability of the project for the promoters. However, understanding the causes may help in curbing the problem and contribute to an improvement in management and productivity, inevitably making the sector a more productive one. The goal here is to make information available that will help develop and deploy attenuating measures as well as strategies and techniques geared specifically towards the management, prediction and control of the causes for delays. These would have an impact on the project's design and construction management stages and would then ensure greater success where compliance with schedules and deadlines is concerned. This would substantially improve the competitiveness of the Portuguese construction industry.

2. The present study aims

A PhD thesis named “Construction delays” has been developed by author João Pedro Couto. The main program task was a survey carrid to Portuguese construction stakeholders. This paper occurs mainly about the aims of PhD survey, general research method deployed, the international state of art and finally will be presented the preliminary results obtained and recommendations or measures to mitigate the problem of the time overruns.

To help improve the performance of everyone involved in the construction process, it is very important to look into and evaluate the aspects pertaining to causes for delays that have an impact on the output of construction companies. To this end, the literature available was analyzed undertaken bearing in mind the following aims:

- To catalogue and analyze the factors, reasons and motives for delays discussed in extant bibliography;
- To glean information on classification of, as well as methodologies to evaluate, delays, claims and related issues;
- To understand, compare and draw out the specific traits of the causes specific to construction Portuguese sector and contrast what is found in international data.

To make this possible, not only was collect bibliographical information and proceed with the analysis of the traits found in the national construction sector but also was asked a number of people for their opinions. These people were promoters, company owners, construction owners, public institutions, contractors, designers and other relevant construction personnel. They were asked to provide a data set that would validate current concern and allow for a more realistic insight into the problem, and increase our knowledge and understanding of the reasons behind overruns.

3. PhD survey

The specialized bibliography indicated that recently there have surfaced studies on the methods for analysis, quantification and accountability for delays, as well as on the deployment of measures to control causes of delay in the design and construction stages [1], [2] and [3].

Once studied the bibliography and complemented, double-checked and contrasted the data therein against a number of opinions published by several

relevant parties in the sector, drafted a map of causes for delay in Portugal
Then a few national specialists, consultants and researchers in construction management were consulted about the adequacy of this cause map that we'd drafted, and then elicited opinions from national and specialists about the importance and meaning of studies of this kind to the delay control and competitiveness in the construction sector. Having defined the cause map, we drafted a questionnaire based on it. The map now featured an analysis of the relationship between delays and accidents in the workplace, as well as an analysis of the legal framework for delays in construction projects in Portugal.
One hundred questionnaires were sent to contractors, 85 to consultants and project designers and 100 to construction owners. The main intent was to ask questions that would clarify the causes mentioned in the survey and observe procedures so as to resolve them.

The answers were provided by administrative personnel or technical staff in management positions then working with construction companies, as well as public owners, consultancy and engineering firms, design firms, management directors, project directors and managers and senior engineers.

59 contractors, 26 designers/consultants and 79 by owners answered to questionnaire.

4. Survey results

The survey results appear to confirm that the responsibility for delay can be ascribed to all parties involved. The statistical and mathematical analysis is still under way, but we can now publish some of our more evident conclusions from the data gathered.

Of the 118 causes contemplated in the survey, we now present an extract of the 5 that were most highly ranked on a scale of relevance by 4 groups involved in the construction sector (Public owners, Privative owners, Contractors, Designers /Consultants) [4].

1) Incomplete projects, ambiguities, errors, omissions, inadequate details, details inconsistent throughout special teams, inadequate design, etc.
2) Excessive dependency on opinions and authorizations from several institutions and ruling bodies (city/town halls, IPPAR – Portuguese Institute for Architecture and Patrimony, Environment Institute, etc.)
3) Difficulties in obtaining licenses and permits from authorities
4) A tendency to use procurement systems with a bias toward the cheapest solutions
5) Deficient planning, activity/material/labor and equipment management and control

Based on the opinions provided by the respondents, the preventative measures and recommendations, that will help lessen the construction delays are for example:

- The need to implement a national database with the quantity works list for different construction projects - this project is now under way;
- Implementing more appropriate and efficient organizational systems within design teams;
- A need for greater care on the part of the owners when they prepare their schedules and preliminary programmes;
- A need for greater precision when preparing viability studies;
- Raising awareness with those involved about the risks inherent to construction;
- A need to optimize management with a basis on qualification and the use of more adequate techniques;
- A need to update some inadequate legislation so as to clearly define and segregate responsibility and liability, and so on.

References

[1] Bubshait, Abdulaziz A; Cunningham, Michael J., (1998) Comparision of Delay Analysis Methodologies, *Journal of Construction Engineering and Management*, Vol. 124, Nº 4, July(August, pp. 315-322.

[2] Finke, Michael R., (1999) Window Analyses of Compensable Delays, *Journal of Construction Engineering and Management*, Vol. 125, Nº 2, March/April, pp. 96-100.

[3] Kartam, Saied, (1999) Generic Methodology for Analyzing Delay Claims, *Journal of Construction Engineering and Management*, Vol. 125, Nº 6, November/December pp. 409-419.

[4] Couto, João Pedro; Teixeira, José M. Cardoso, (2005), "As consequências do Incumprimento dos Prazos para a Competitividade da Indústria de Construção – Razões para os Atrasos", 3rd Conference ENGENHARIA`2005, 21-23 November, UBI - University of Beira Interior, Covilhã, Portugal.

The booklet of the building as an instrument of planning and management in the building process

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In this way booklet permits a thorough systematic practice, which indicates and evaluates the drop in performance of the technical elements and the technological subsystems over a period of time, providing the measures of intervention and planning required.

Keywords: booklet-type, feedback, procedural planning, check up, building certification.

1. The concept of booklet

This proposal introduces a few concepts from the booklet of the building which can be applied to the management of durability and maintenance in the building process. There are several reasons for this, such as; the continuing concern for quality and safety in buildings, a growing interest in resource conservation in the building and construction sectors, with particular attention being paid to the issues of durability and maintenance, as well as the building object and the optimisation of maintenance programmes. The framework booklet is set out in four main fields:

- Part 1 The registry of the building
- Part 2 System of validation
- Part 3 System of diagnosis
- Part 4 System of maintenance [1]

These systems are the basis of management control of durability and maintenance in the building process. By these means progress and innovation in the building process is favoured, through a flexible tool like the booklet–type.

2. The question of the assessment in the building process

The planning of maintenance interventions, preservation and renovation, the revision of the project to optimise the cycle of service life of a building and its items, the reduction of environmental impact, and the need to avoid the risks of unforeseen deterioration, have become indispensable objectives in the management and sustainability of the property in the building process.

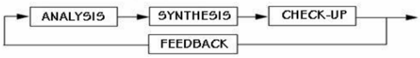

Figure 1. The plan to make process for the building project.

The service life of each component is directly related to the design stress. It is insufficient and risky to merely copy details from previous projects without considering the surrounding environment. Prescribed solutions must be based on a detailed analysis of the performance requirements for the actual component in the building system, as a basis of service life modelling for the interaction between the material and exposure conditions (data collection) [2]. Durability is influenced by every component in the building's development. It is also affected by the judicious use of durable materials that are hard to obtain or maintain during the service life of the building. The aim of a test or a survey is to predict a service life, defined as the period after installation during which all conditions of a component meet or exceed all established performance requirements. Accordingly, for each of the requirements, the corresponding performance characteristics are recorded during a test or survey (Maggi, cited in [2]).

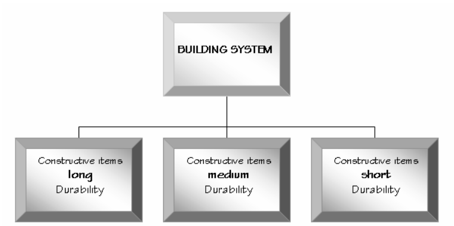

Figure 2. the chart building system for durability class.

By all means, the construction of a building demands meticulous attention especially in reference to:

- selecting materials and systems that are compatible with each other, that have at least a reasonable record of performance, that are durable within the designed lifetime, and that can be maintained and serviced effectively;

- the complexity of buildings with thousands of disparate materials and combinations, assembled by agencies that can have conflicting schedules and interests;
- constructing as specified, thus obtaining the maximum utility from the required materials and combinations, and from quality and fully qualified workmanship;
- utilizing materials that have been researched and tested sufficiently to assure that they are fit for their intended use;
- eliminating trendy and untried methods and materials, especially when they are difficult to reach after construction and could be costly to replace.

3. The booklet framework

In the aim to streamline the booklet of the building was born. In fact, in Italy one of the first definitions of booklet of the building is provided by the D.D.L. n. 4339/99 (art. 1), which outlines the file as a tool where (…) the information concerning the building is written according to the identification, the project, the structure and the plant, arriving at a fit picture of information starting, where possible, from the phases of construction, and where the modifications are registered and compared with the original configuration, with particular reference to the static, functional and installed components of the building (…).

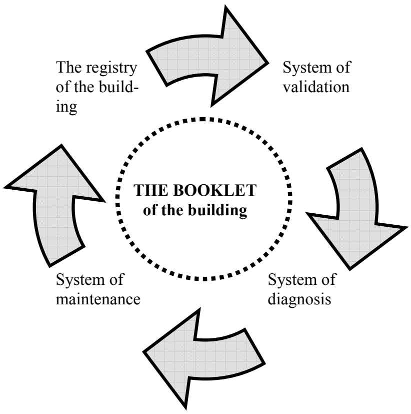

Figure 3. The Chart flow of the booklet

The booklet of the building outlines the following characteristics:

- It is complete (from the point of view of the information in its content), but not, aimed at operations management of the building;
- It allows for the evaluation of given performances of each single component and their interactions, and facilitates the systematic activities of analysis and monitoring (diagnosis of control, etc.);
- It includes particular instruments of evaluation concerning the phenomena of modification during service life of the organism (anomaly, defect and fault);
- It is flexible, so that it can be updated in accordance with the phases of control (indispensable peculiarities and properties, and also allows interaction with an information system);
- It can be managed by several users with different technical-cognitive levels (maintenance staff, residents and users of the building, specialised technicians, etc.);
- It is necessary and fundamental to categorize the building types (distributive and morphologic characteristics, etc.) and the related prevalent building technologies into their environmental differences, by specific articulation and by identifying single building subsystems, spatial units, and so on, through ordinate schemes of classification (Rejna, cited in [1]);
- It is possible to put into motion the activities of operative management for maintenance plans or the plans for realignment of the performance, etc.

4. Knowledge maintenance

The use of the building booklet is to forecast maintenance objectives, and the purpose of the booklet is to provide a complete result through specific analysis and technical evaluation in order to enhance the maintenance criterion of the whole building in line with performance satisfaction. Opportunely planned maintenance can help to realise the regular functioning of the building without prejudice of use. The procedural elements considered must be improved, extended over the course of time and tried in an open laboratory, where feedback can aid in perfecting the methods of planning and management, to involve all the driving forces of the building process to create a flexible booklet–type.

References

[1] M. Rejna (2002), “Metodologiaapplicata alla progettazione e alla programmazione della manutenzione in edilizia”, Ed. Epitesto, Milano.
[2] P. N. Maggi, (2000), La qualità tecnologica dei componenti edilizi, La valutazione della durabilita’, risultati della prima fase sperimentale, Ed. Epitesto, Milano.

The management of student related facilities in higher education

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The renewal programs that universities are carrying out result from the new awareness that curricula should be more student-centred and that the quality of facilities are one of the most important factors in the recruitment and retention of students. This paper outlines a reliable model for the necessary and urgent renovation process that encompass four main steps: accurate analysis of actual conditions and future needs; the definition of space/cost planning standards; the development of a theoretical model that could describe future scenarios and a continuous benchmarking evaluation.

Keywords: Student center, facilities, standards, benchmarking.

1. University students related services

In recent times universities have been developing organizational and structural renewal programs. New learning paths have been introduced, new technology and pedagogical studies have changed teaching methods. The different needs of students, in addition, have required a novel and more responsible approach to environmental needs. Campus and university should offer more qualified services, not only in regard to educational or knowledge transferring areas, but also in regard to those aspects that concern the whole university life experience. Building and organizational structures had to be more student-centred and offer more qualified facilities for study and leisure activities, sport, socialization and all life requirements. Furthermore student centers have a strong influence in the recruitment and retention of students. In the Anglo-Saxon universities and campuses we can find a specific building that hosts most of students' activities. We refer to the so called Student Centre or Student Union that embodies three significant concepts: visual connections, physical relationships, and symbolic representations [1].

2. The student unions of "Net generation"

Student Unions are characterized by a significant refurbishment and renovation process. These changes are remarkably influenced by technology innovation. Currently the students of "Net generation" [2] are technologically oriented in their entertainment habits and always use tools (cell phones and web connections) that allow remote social interaction. This pattern suggest that students are no longer interested in "traditional" socialization activities. Differently students often participate in collective events such as movies, late night breakfasts, outdoor concerts and dances, cultural festivals, etc.

Students require the continuous availability of services, such as laboratories for creative and craft-based activities, art exhibit spaces, music rooms and innovative sport facilities [3]. There are two different alternatives that can meet these goals: the compact and satellite configuration. According to the first alternative, the union building has the main role of gate with the "external world" communicating a positive impression to visitors and recruits. In this case it should provide orientation and service to immediate needs of students. At the same time the compact configuration should aim at gathering other students, as an extension of a living space that re-creates domestic atmosphere. In this context students could spend free time, cultivate and share interests and curiosity, debate and promote joint initiatives. The second type of configuration relates to the so called "Satellite Union buildings". Students can easily take advantage of the services that are located in the lounges in their own department. This type of configuration should provide a dynamic combination of learning and service spaces, such as in the case of a village square or street that promotes direct communication among students and reinforces the sense of community.

3. Standards

The proper characterization and planning of facilities builds upon guidelines, dimensional parameters and standards that help in making the right decisions in regard to the size of student population, context and goals. In higher education, space standards for teaching, research and administrative activities have been already developed. However it is more difficult to define standards for students related facilities because of the difficulty in defining the exact number of users and the strong relationship of this type of facilities with the surrounding context. In the area of higher education space planning and utilization standards are receiving increasing attention because they help in improving capital planning, budgeting, and management. Standards are subject to different interpretations. Three typical standards can be noted[4]:

- Space standards that define the requirements for student capacity, square-foot allocations and use.
- Functional standards that link the specifications for educational space and equipment with the specific requirements of teaching or learning curricula.
- Design standards that typically include the quality performance, durability and condition requirements of building systems.

It is possible to select and customize other types of standards in relationship to the specific purposes and priorities of any given university. Space standards can be differentiated according to [5]:

- Space Planning Standards or guidelines that are used for the analysis of campus capital needs. The guidelines results from comparing existing space conditions with future possible space needs as to develop accurate capital programs.
- Space Utilization Standards or guidelines for the comparative analysis of space use productivity that is mainly based on room utilization rate.
- Space Programming Standards. Sometimes they are called "design standards", such as the architectural planning criteria for the exact sizing of individual rooms that eventually set the overall dimensions of a given project.

4. Benchmarking

The process of defining standards is a complex one and it requires to move away from the traditional use of fixed numeric values, to be applied in any situation. Standards results from a complex iteration process that evolves continuously and may concern different and specific realities. This process typically is characterized by four main phases: audit, standard definition, modelling and benchmarking. The latter, on paper, allows university staff to ascertain performance trends and undertake continuous self-improvement activities. Reference and quantitative criteria are two important kinds of benchmarking [6]. The approach to the criterion reference simply defines the attributes of good practice in a functional area. Quantitative criteria, on the other hand, aim at defining normative and competitive levels of performance achievement. Possible benefits from benchmarking include the meeting of critical and basic needs without overbuilding, credibility and transparency, improved deferred maintenance, elimination of unwarranted projects. Other benefits are the demonstration of fiscal responsibility, the capability of developing better annual monitoring tools and, lastly, improved facility efficiency and effectiveness. One of the most critical challenges of benchmarking, at the moment, relates to quality data collection, manipulation and improvement. In spite of the fact that many national programs have defined fixed rules and fields of investigation, there are remarkable differences among universities. The latter, in fact, pays different attentions to these parameters, depending on their own goals and measurement criteria. The current situation of Italian universities requires timely and opportune strategies that improve the quality of the whole system of higher education. The most correct approach consists of a comprehensive and systemic analysis of existing conditions referred to actual and predicted needs. The definition of standards, as they result from collected and shared data within each university, could facilitate the meeting and maintenance of prearranged goals. This process, however, should be continuously reviewed and adjusted as to ensure "that the result will be a well-rounded, forward-thinking, lasting action that truly addresses to important concerns" [4].

References

[1] Taft, K. (2006), *Student Unions: Campus as One***,** Facilities Manager, vol.22, n.2, http://www.appa.org/FacilitiesManager/

[2] Fisher K. (2005), *Learning Environments in Tertiary Education*, TEFMA, Learning Environment Seminars, Commonwealth of Australia

[3] Turner N.A. (2002), *Student Activity Center Trends*: *What are today's students doing, and how should facilities change to accommodate their activities?,* College Planning & Management http://www.peterli.com/cpm

[4] Bentley, M. (2004), *Standards, A Measuring Guide*, School Planning & Management http://www.allbusiness.com/periodicals

[5] Kaiser, H.H.; Klein, E. (2006), *Space Standards: Some Recent Lessons*, Facilities Manager, vol.22, n.1, http://www.appa.org/FacilitiesManager

[6] Mc Kinnon K. R.; Walzer S.H.; Davis D. (2000), *Benchmarking: a manual for Australian University*, DETYA, Commonwealth of Australia http://www.detya.gov.au/highered/

The problem of information about information: An action plan

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Management in the construction sector includes knowledge management, just as it includes communications management; what is often overlooked is the management of the information which knowledge acquisition and effective communication depend upon and which is the basis of well-managed decision-making and action. There is a "problem of information about information" in the construction sector. Attention has been given to various approaches to improving the performance of the construction sector, through e.g. re-engineering, the performance approach, innovative procurement and information technology. These affect the roles of the participants in the building process and the relationships between them, and consequently impact on the kinds of information that is required to support a novel distribution of responsible decision-making Conversely, a systemic approach to information and its processing will impact on the effective adoption of the wished-for changes. This requirement applies not only to project-specific information as it develops over the life of a project, but also to general information and in particular to the transfer of information from research to practice. Research has confirmed (a) the importance of information and its accessibility as a factor of the efficiency of the building process and (b) the almost complete lack of research into this problem. An action plan has been established and an initial group of international participants has been formed.

1. Introduction

Project management has many facets - but necessarily includes the management of decision-making, which in turn includes (or, rather, should include) mastering the flows of information needed by decision-makers. In fact, even though this is a global problem, very little work is being done on understanding the relationship between *adequate information* and *well-managed construction projects*, particularly in a contemporary context of process innovation. Indeed, research has confirmed (a) the importance of information and its accessibility as a factor of the efficiency of the building process and (b) the almost complete lack of research into this problem.

There is, in other words, what can be called "the problem of information about information" in the construction sector. In the situation of today, the architect has the problem of knowing (or rather: not-knowing) all that is pertinent for his/her tasks. This is coupled to a kind of naïve optimism that the over viewing (i.e. synthesis) activity that is inherent in the creative process of design overrides the need for relevant information for all levels of decision-making.

This paper presents this problem and proposes a plan of action, starting with a workshop at this conference. Many organizations are concerned about improving the performance of building design and production activities and are initiating "proactive" research efforts. However, an essential complementary program of activity has been neglected. In an environment of hoped-for innovation, it is high time to study *information* as an essential ingredient of the production of buildings.

The objective of the workshop that this paper supports, is to lay the foundations for a concerted effort (i.e. a research program) to understand and improve the use of information for better decision-making in building, and thence for a quicker adoption of innovations. The underlying hypothesis is that better decisions are made when better information is used for making them, suggesting that process-oriented information systems will positively impact on the performance of project groups. Unfortunately, there is also evidence that time spent searching for information is not considered to be time well spent.

2. The building industry's information context

The structure of the industry and the habitual processes by which projects are procured, designed, constructed and maintained, and their component parts specified and manufactured, all seem to explain, if not justify, this apparent reluctance to innovate. The explanations include:

- the fact that the building industry is composed of a large number of different (and generally small or very small) firms and enterprises,
- the fact that building projects are entrusted to groups of participants who are brought together from within this multi-industry - through the building owners' procurement strategies - for the duration of each project,
- the fact that any effort regarding information (retrieving and reading it) is currently *not* regarded as a productive use of one's time

- the fact that the presentation of information is governed by traditions that prevail, and it is still commonly accepted that skill is required for the interpretation of instructions. This suggests that when there is any change from traditional practices (e.g. when there is innovation), the traditional approach to dealing with information may no longer apply. The information related to innovation will probably upset the reliance on this "interpretation skill", potentially leading to acute communication problems and putting a brake on innovation itself.

Within this building "multi-industry", the various participants can be described in terms of their "information appetite", namely the amount of information required in their professional activities.

3. An action plan

In this way of looking at the building process and the emerging trends, *information* appears as a key ingredient, particularly in any attempt to re-engineer the building industry, or improve its capability to innovate through its hoped-for adoption of the performance approach. The absence of an understanding of the key role of information translates into a *problem of information about information*. We base our concern for research into "information" (its generation, its warehousing, its movement, its retrieval and its use) on the concomitant need for changing the building process. There is a two-way influence (a) between changing the approaches to the organization of the building process on the one hand and mastering the use of information on the other, and, conversely, (b) between novel approaches to information and strategies for improving the building process. We suggest that information is (or more realistically, *ought to be*) the kernel of research in this quest for improved building through quicker and better innovation (both organizational innovation *and* technical innovation). In short, we suggest that there is an "information problem" to be solved before there can be any significant innovation. As a consequence of the *problem of information about information*, its ramifications in the areas of building process re-engineering and of technology transfer, and as a consequence of the lack of antecedents described above, a *program* of research is called for. This program comprises a set of related exploratory research activities leading to fully-fledged cooperative research *projects* addressing this relatively unexplored domain.

3.1 Research questions

The research program on the problem of information about information posited here suggests research questions such as:

- What kinds of information are required for innovative building design, manufacture and construction, including process management and control, and building maintenance and use?
- Where can this information be found?
- How is it (or could it be) taken up and used by professionals and enterprises, who for various reasons, choose (or are obliged) to work within an innovative approach?
- How is performance-related information adapted for use at the various stages of project development?
- How does re-engineering affect the flow of information within a re-engineered building industry? How does this modified flow of information affect the scope for innovation?
- How is information flow affected by various novel procurement strategies?
- Do contemporary models of a re-engineered building industry take into account the impact on the flows of information within the sector?
- Can understanding the needs regarding the flow of information have a positive impact on attempts to re-engineer the building process?

4. Conclusions

The worldwide “problem of information about information”, coupled to the fact that only a few research groups are tackling it, suggests that indeed an action plan is timely, if not overdue. The action plan proposed here is based on the premise that today’s communications technologies allow for efficient networking between researchers. Specifically, the proposal is for establishing a *program* of research which addresses the questions raised here, and for establishing a relatively informal and decentralized structure to identify missing areas, to share the work, to provide moral support for decentralized fund raising and for disseminating the findings back into the building industry, also worldwide. This paper provides background information and a broad-scope vision of the challenge, and is intended to serve as springboard for the workshop that forms part of this conference. It is also an invitation to participate.

A new enclosure heat storage system (a brief history of C-TIDE craft research)

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Direct gain due to solar radiation through external walls can lead to overheating, particularly using light building techniques. The use of building-integrated Phase Change Materials (PCM) is a possible solution and was also investigated in the C-TIDE Craft Research. In this Research Building Industries (Vanoncini, Poggi) and Materials packaging Industry (Climator) collaboration are useful to Research team (PCQ - Italy and BMG - Sweden) work.
This paper illustrates several building solutions regarding PCM panels – any of the results of the EU-funded C-TIDE research. PCM panels was experimented and compared to a similar elements without the artificial storage element. This new technology demonstrated its ability to lower thermal load peaks and, more importantly, it demonstrated its ability to shift the peaks during the hours of the day in which they are useful for guaranteeing a stable temperature within the internal environment.

Keywords: PCM, latent heat storage system, heat transfer, passive cooling, low energy consumption

1. PCMs in buildings

The aim of C-TIDE (*Changeable Thermal Inertia Dry Enclosures*) research was to test walls built using a “dry” technology capable of coping with the thermal comfort problems that characterize such building technologies. This problems are linked to the low thermal inertia, which leads to high use of HVAC systems, often with high levels of consumption and low environmental comfort (overheating or excessive cooling of surroundings).
Storage of thermal energy can be performed by latent heat of the Phase Change Materials (PCMs). Latent heat storage is a promising technique as it provides a high-energy storage density band that has the capacity of storing heat at a constant temperature.
The heat produced by melting is 80 to 100 times larger than the heat required for heating a material one degree. PCMs absorb and emit heat while maintaining a nearly constant temperature. Within the human comfort range of 68° to 86°F (20° to 30°C), latent thermal storage materials are very effective.

2. Applied methodology and scientific achievements

Whole building behaviour. C-TIDE research group has worked to define a design procedure aimed at the definition of buildings’ thermal performances, in connection to their previously chosen climatic and design contexts. The analysis of thermal fluxes crossing the building’s structure allows a first definition of the amount of PCM needed inside stratified enclosures in order to ensure comfort conditions while limiting the use of cooling systems.
The results obtained seem to confirm the advantages due to the presence of the PCM layer in the external enclosures whose task is storing all the heat coming only from the exterior.
In conclusion, the simulations offers the possibility of calculating, in hourly transient state, the in-coming heat fluxes through the walls, in a reasonable period of time, varying climatic contexts and the building model used. This fact allows the building’s designer to decide, in a first design phase, the strategies with which excess heat is to be stored, before doing a “final-functional” simulation of the stratified enclosure (melting temperature of the PCM, amount of PCM, place and kinds of material, etc..)
External walls behaviour. In this research step, results and evaluations relative to 3 functional models are listed.
In the first Functional Model, a layer of PCM was sandwiched between the internal and external subsystems of a typical low thermal inertia dry enclosure, made up of its external and internal finishes and a layer of insulating material. The PCM layer was placed behind the external finish, trying to absorb all the in-coming heat flow during the summer period; in this way we avoid the internal surface’s overheating. During the night the heat flow will go towards the external part of the wall, due to the presence of the insulating material at its back.
The second functional model was thought to avoid any problems connected with PCM solidification during the night, that’s to say making its de-loading as speed as it is possible.
This stratified envelope is made up of the internal and external finishes, an air layer, which can be venti-

lated, one PCM layer and an internal insulation layer, settled behind PCM.
In climatic contexts where there is a great quantity of solar radiation hitting the external surfaces of buildings it is worth avoiding the solution of increasing the PCM's thickness and to accept the strategy whose purpose is postponing the moment in which the PCM layer reaches its melting point. This purpose could be reached, for example, placing an air layer, at the external side of PCM, which provides a considerable thermal resistance against the passage of heat (the third functional model)
The behaviour of PCM placed inside the walls described above was studied through the finite element analysis applied on numerical models built for that aim.
As a conclusion, the First Functional Model (without the air layer) seems to ensure internal comfort conditions for climatic context characterized by great temperature difference between day and night. If there are low thermal day-night temperature differences and strong solar radiation, the most advisable model is the Third one (with the air layer in front of the PCM). If there are average-low solar radiation values, the Second Functional Model (with the air layer behind PCM) gives the best warrantees, particularly if the temperature difference between night and day is quite low (otherwise even the First Functional Model can be used in this climatic conditions).

3. Test results

The research workgroup carried out two experimental campaigns aimed at evaluating the behaviour of PCM containing walls and validating the simulation methods hypothesized using software programs.
In order to have available a number of standard size walls (3 ml), 8 envelopes (boxes measuring 3x3x3ml with a south facing PCM containing wall) were built instead of one only multi-storey building which will have limited the possibility of diversifying the technology at the South facing walls.
As can be deduced from the values obtained, all boxes clearly demonstrated that the PCM increases the thermal inertia of the south wall.
The data obtained is quite positive and they were analysed in comparison to the results obtained in the reference boxes.
The behaviour of the South stratification is object of the comparison. For each box, a graph containing the time period and the temperatures was created, the different lines are the values recorded by the different thermal resistors installed in the walls' various layers.
If with the first experimental campaign only a preliminary study of the potentials of light PCM containing walls was carried out, with the study done regarding the results obtained by the second experimental campaign it was possible to demonstrate the importance played by the PCM, particularly in the relation to the ability to improve its inertia in regards to solar radiation, which is the most important overheating cause of light type panels.
In general, it is possible to state that a PCM containing wall is much more sensitive to external atmospheric conditions as compared to the reference wall, that is, it's behaviour is typical of heavy structures but, it has the advantage of being built with industrialized technologies typical of light walls.
As far as concerns walls containing a ventilated inner air chamber between PCM layer and insulation, it guarantees greater protection as compared to the one without ventilation: for example, solar radiation sets off a ventilation which can remove heat from the external environment, however it is much more difficult to control during night time when forced ventilation is required to help unload the heat accumulated by PCM during the day time, otherwise, we risk restoring all of the heat to the inside. An analysis of the costs/benefits must be carried out every time a decision must be made concerning which solution should be adopted.

References

[1] Feustel, H; Stetiu, C.; *Thermal performance of Phase-Change Wallboard for residential cooling*, CBS Newsletter, Fall (1997).

[2] Khudair A.M., Mohammed M.F.; *A review on energy conservation in building applications with thermal storage by latent heat using phase change materials*, Energy conversion and management, n. 45 pp. 263-275 (2004)

[3] Lemma M., Imperadori M., Fioretti R. "*Development of a technology for inserting a PCM layer in building envelopes*", XXXIII IAHS World Congress, Pretoria, South Africa 2005.

[4] Lemma M., Torcianti N., Mori F.; *Experimental evaluation of artificial programmable inertia walls*, Proceedings of XXXII IAHS World Congress Sustainability of Housing Projects, Trento, Italy (2004);

[5] Stovall T.K., Tomlinson J.J.; *What are the potential benefits of including latent heat storage in common wallboards?*; Journal of Solar Energy Engineering, Transaction of the ASME, v.117, n.4 pp. 318-325 (1995)

The "Living Building" concept: starting a first experiment

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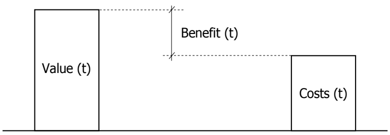
The Living Building Concept (LBC) aims for improvement of both users benefit as well as suppliers profit over the whole life of a built object. Instead of contracting a fixed scope against a fixed price at the start of a contractual period, the LBC starts with an initial price for an initial scope (performance) and measures and reimburses the actual performance during the contractual period. In this way the LBC keeps buildings fit for purpose and up to date in the fast changing world inside and around a building. Moreover, LBC substantially reduces transaction costs and risks because there is no need to predict all possible scenarios in order to set a firm fixed price. At the moment an experiment is commenced with a long term DBM contract for a new school in Veenendaal in The Netherlands. This paper describes the contractual implications of the LBC. The whole life value delivered is expressed in terms of psychic, functional and technical value. The costs are expressed in capital, operational and maintenance costs. Value and costs are coupled to the price with a formula agreed upon by the client and the contractor (supplier) at the start of the project. During the process the changes of the value required and delivered are measured, and thus the changes in the price and the costs can be measured too. In the contract the client is responsible for the changes of the value required; the contractor is responsible for the value delivered.

Keywords: Construction, Contract, Costs, Life cycle, Value.

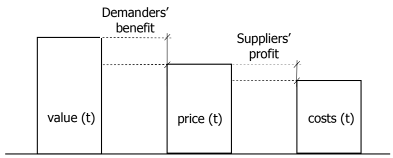
1. The "Living Building" concept in construction

The Living Building concept (LBC) presented in this paper is called the "Living Building Concept" to indicate the dynamic approach to built services, the construction project and the life cycle, and has been introduced by both authors before [1] [2]. The aim of construction is to produce an acceptable difference between value on one side against costs on the other side. The difference between value and costs is the total benefit. This benefit is for all involved parties



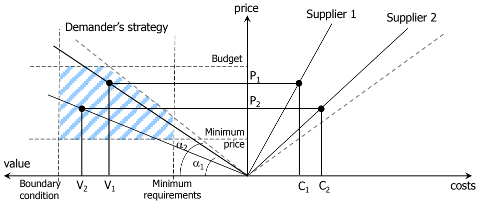
The problems of perception and the dynamics of construction life cycles call for a dynamic interrelated and long term approach to the demand and supply of built facilities aimed at systematic and adaptive maximisation of the total life cycle benefit. When the total value could be interconnected qualitatively and quantitatively to the total costs of a built service and parties would agree on the algorithm between value and costs, then the collective of demanding and supplying parties can aim the process at achieving the highest possible benefit to the mutual advantage of both demanding and supplying parties.

The initial price will grow within this dynamic process in a controlled way to a final price. Instead of enforcing the initial planned value against a fixed price calculated in the first phase of the process, the price is based on the actually delivered value at the end of the process. The final price will never exceed the budget of the client. The range between initial price and maximum budget can be considered as the client's "control budget" for dealing with problems of perception. On the supply side, contractors and other parties are enabled to reduce costs or increase value.

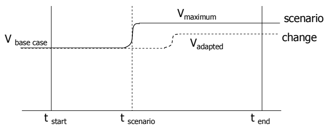


2. Principles of the "Living Building" concept

The main principle is that changes of the building or construction are regular events instead of exceptions. This means that the client is not considering all possible scenarios with respect to influencing factors and finally bring them into one extreme scenario for the lifetime of the building covering all imaginable circumstances and leading to over- dimensioned buildings with associated oversized cost estimation. Instead, the Living Building Concept is aimed at a “”Fit for purpose”” and an “”Up to date”” building right from the start and will adapt the building to changing circumstances only when needed. This means that LBC starts with the "best guessed" value at that particular moment.



The ultimate goal is to find the maximum benefit possible for clients and other stakeholders, as well as the contractor and suppliers, i.e. best value for the client at minimal costs for the supplier. Client and supplier share the benefit by finding a right price in the middle. This implies measuring and rewarding value delivery, minimizing adversarial relationships and collaborative decision making leading to “best client value” [3]. Besides “value optimization” also target costing should be applied. This kind of “value for money” approach has the largest potential in the early stages of the project, i.e. the briefing phase, when strategic decisions are made, together with application of integrated life cycle contract types [4].



Starting point is that the real scenarios (actual changes) during the lifetime will all be a part of the extreme scenarios. The advantage of this method is that the prices of changes are made in competition, and that the client should define the changes as a part of the scenarios. It does not only facilitate easy decision making for the client as the price of a change is always known, but it facilitates also a good collaboration between demander and supplier, because they are not only aware of risks but also opportunities. The price of an actual change can easily be determined from the scenarios.

3. Case Veenendaal School

The selection procedure contains three steps: (1) Preselection leading to 5 competitors, (2) Pre bid selection, leading to 3 competitors and (3) Final selection after competitive dialogue leading to the preferred supplier. The aggregate price is the sum of the base case price, the maintenance price and the price for a reference scenario which is a mixture of the three defined scenarios. Moreover, the psychic value which is the result of the detailing will also be part of the final bid and will be evaluated by a committee. At the end of the first contractual period, the maintenance contract over the following 10 years will be tendered. The first supplying party is also allowed to bid and has the opportunity to revise his first estimation of maintenance cost after the first 10 years. When the winning competitor comes up with a lower price than was estimated, the first supplying party will be rewarded with 50 % of the difference for well performed maintenance.

4. Conclusions

The “living building” concept represents a new and comprehensive approach to demand and delivery of built services, based on a dynamic approach to the construction process and the life cycle. It solves problems of perception and process statics. It offers great potential advantages to demanding parties (clients, users etc.) as well as supplying parties (contractor, suppliers etc.). Particularly the continued dynamic approach, performance measurement and involvement of parties through the life cycle imply a great endeavour for clients as well as suppliers. The case shows that the Living Building Concept can be applied in practice. It is not only possible to measure value and cost in the bid phase of a project but also to determine extreme change scenario’s which form a firm basis to control actual changes of a building when measuring the changed value and paying the associated price. As the suppliers will be invited to bid on a base case and predetermined scenarios, the risks are minimal. In consequence the transaction costs will be reduced significantly. In all, the case shows that the LBC concept will lead to maximum benefit for all parties at the end of a project, which results in client’s added value and supplier’s profit.

References

[1] De Ridder, H. and Vrijhoef, R. (2005). "A new paradigm for construction demand and delivery: developing a "living building" concept". In: Proceedings CIB Combining Forces, Vol. 4, 13 June 2005, Helsinki, 164-174.

[2] De Ridder, H. and Vrijhoef, R. (2006). “From demand-driven supply towards supply-driven demand in construction: a “Living Building” Experiment”. In: Proceedings 3rd International SCRI Symposium, 3-4 April 2006, Delft, 530-542.

[3] Kashiwagi, D. T. and Khiyara, B. (2002). "The optimization of value engineering as a structural component of the construction procurement process." In: Proceedings COBRA, 5-6 September 2002, Nottingham Trent University.

[4] Kelly, J., Shen, Q. P., Hunter, K. and Yu, A. (2003). "The development of a theoretical framework for being using a value management approach." In: Proceedings COBRA, 1-2 September 2003, University of Wolverhampton, 328-337.

Competition and the characteristics of construction markets

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The objective of this paper is to discuss issues associated with the conditions under which competition between construction firms occurs, in the context of the economics of markets. Different views on the application of market structure models to the construction industry are discussed, in particular the widespread acceptance of perfect competition as the norm. This is followed by an analysis of the ability to exercise market power and the degree of concentration in the industry. Then two important characteristics of markets are applied to the construction industry, product homogeneity and barriers to entry. The paper then argues that the actual degree of competitiveness of different sectors of the industry varies at both the contractor and subcontractor levels. The arguments for this alternative approach conclude the paper

Keywords: market structure, construction markets, contractors, subcontractor

1. Introduction

This paper analyses one how competitive markets operate in the construction industry. The type of market an industry operates in is known as its structure, and in microeconomics there are four types of market. The type of market found in the construction industry is a point of debate among researchers and analysts and the aim of this paper is to establish the relevance of different market types to the construction industry. The significance of 13 barriers is assessed for four different market types, based on product characteristics.

2. Market structure models

In neoclassical economics there were initially two extreme types of market, one full of competition and the other without any competition. Because many industries do not have these characteristics and fall between perfect competition and monopoly the alternative models imperfect competition known as monopolistic competition and oligopoly were developed. Under monopolistic competition there are many small firms with limited control over price, producing either identical or differentiated products supported by brand names and marketing with some (often important) barriers to entry (Bain 1956). The key characteristics of an oligopoly are a few large (but not necessarily the same size) firms and significant barriers to entry. Industries that are concentrated oligopolies produce homogenous product (steel, cement, basic chemicals, electricity), while differentiated oligopolies are found in consumer goods markets (computers, automobiles, banking and insurance) (Sylos-Labini 1987: 701).

3. Arguments for perfect competition

In many construction or building economics texts the starting point for discussion of markets is perfect competition. Runeson (2000) examines the structure of the industry and the level of competition based on the idea that market structure determines conduct, which in turn determines performance. His conclusion on competition in markets for building was "firms behave as if they were operating in a very competitive market where price is determined by the competition. That is all that is required for the markets to be defined as perfectly competitive" (Runeson 2000: 142)

4. Ability to exercise market power

In Hillebrandt's (2000) view the key characteristics of construction industry markets are the type of product, and size and complexity of the contracts, because as these increase the number of firms capable of undertaking the contract diminishes. She links the system used to select contractors to a specific type of market and uses the procurement method as the key distinguishing factor between different market types found in construction. In contrast to Runeson, Hillebrandt does not see perfect competition as the typical market type, but as specific to certain stages of the selection process under certain conditions. The Hillebrandt concept of construction markets is clearly an adaptation of microeconomics to accommodate the characteristics of a project-based industry.

5. Concentration in construction

The degree of monopoly power exercised by the largest firms in an industry is expressed in the concentration ratio. McCloughan (2004) analysed trends in concentration in the British construction industry at three levels. First, aggregate concentration is low in the British construction industry with the largest 100 private contractors accounting for 20 per cent of activity and 15 per cent of employment. Second, the five-firm concentration ratio (C5) is estimated for general builders at around 10 per cent, building and civil engineering contractors around 20 per cent and civil engineers 15 per cent.

In the analysis of concentration in specialist trades between 1980 and 1999 the results were very different. McCloughan divided these trades into two, a labour-intensive, low capital, easy to enter category including plumbers, plasterers, carpenters and painters that deals mainly with private customers, and a second group of more concentrated trades that work for commercial and government clients. The trades and C5 estimates in the concentrated category are: scaffolding specialists 56 per cent; asphalt and tar sprayers 40 per cent; constructional engineers 36 per cent; insulation specialists 39 per cent; and demolition specialists 31 per cent.

6. Product homogeneity

In construction there are two views on product homogeneity (sameness) or heterogeneity (differentiation). On the one hand the industry produces buildings of many different types, on the other it manages the process of building. Gruneberg and Ive suggest that there are no "clear product markets" or "a tendency towards homogeneity within product markets or a single product market unit price" (Gruneberg and Ive 2000: 107). Runeson's and others answer to this is that the industry is the market for building management services, not for products called buildings. Services are clearly homogeneous, while products can be differentiated.

7. Barriers to entry

There are six barriers to entry identified by Gruneberg and Ive (2000: 97-101), one of which is unique to construction. The typical barriers to entry are economies of scale, supply chains, incumbent cost advantages, private information (including client relationships), and contestable markets. The unique barrier is "client imposed barriers to entry to contract construction markets".

Six barriers specific to the construction industry discussed by de Valence (2003) were: the cost of investment necessary to become a participant, ranging from very low (the building industry) to very high (starting an airline, for example); the market power of incumbents; acquisition of the technology, skills and workforce needed; access to equity and debt finance; the state of the market, or the growth rate in and level of demand; and the intensity of competition and margins available

8. Competitiveness of sectors

Generally, labour-intensive subcontractors and small contractors operate under perfect competition. Capital intensive subcontractors and medium sized contractors will typically be in monopolistic competition, and could have either homogeneous or differentiated products. The type of project and procurement method determines whether large contractors are in a homogeneous or differentiated market, and subcontractors that have significant R&D, capital intensity and strong client relationships are in a differentiated monopoly. The 12 barriers to entry identified are then applied to subcontractors and contractors, with either homogeneous or differentiated products/services under imperfect competition.

References

[1] Bain, J.S. 1956. *Barriers to New Competition*, Harvard University Press, Mass.

[2] Sylos-Labini, P. 1987 'Oligopoly', in Eatwell, J., Milgate, M. and Newman, P. (eds.) *The New Palgrave: A Dictionary of Economics,* The Stockton Press, New York, Vol. III.

[3] Runeson, G. 2000. *Building Economics*, Deakin University Press, Deakin.

[4] Hillebrandt, P. 2000. *Economic Theory in the Construction Industry,* Third Edition. MacMillan, Basingstoke.

[5] McCloughan, P. 2004. "Construction Sector Concentration: Evidence from Britain", *Construction Management and Economics*, 22: 979-90.

[6] Gruneberg, S.L. and Ive, G.J. 2000. *The Economics of the Modern Construction Firm,* Macmillan, London.

[7] de Valence, G. 2003. *Market Structure, Barriers to Entry and Competition in Construction Markets*, CIB W55/W65/W107 Conference, pp. 819-28.

The German housing sector – Building activities until 2025

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The contribution presents a typology based software-tool (BASiS-2) which describes the existing housing stock of Germany and allows the modeling of development paths. The model uses findings from empirical analyses of material-flow and land-use in the housing sector in Germany taking into account the building stock and the essential technical infrastructure facilities. Statistical data on a national level and empirical findings allow to estimate the environmental impact of the housing sector. The BASiS-2-Project was financed by the Federal Environmental Agency of Germany [1].

Keywords: Urban Structural Type, resource consumption, scenarios, housing sector

1. Scenarios

In order to picture the future housing situation two scenarios were developed. Key factors had to be defined and assumptions made on the variables to generate a "Reference" and a "Sustainability" Scenario

The scenario editor of BASiS-2 allows alterations, but these have to be chosen carefully well in order to be logically consistent. The process to define the well differentiated scenarios was time consuming and needed the input of external experts. First the decisive factors had to be identified, then characteristic values hat do be assigned to these factors in accordance with the scenario-visions. Two workshops, one on housing demand in general and one on resource- and land consumption-conscious building activity guided towards the scenario visions. Both scenarios assume similar demographic and economic developments.

Essential for the model is the "urban structural type" approach in order to make out of statistical data "physical" data. Urban structural types (UST) are defined as: "areas with physiognomic homogenous character, which are marked in the built-up area by a characteristic formation of buildings and open spaces" [2]. Thus, they integrate areas with similar environmental, infrastructure conditions and similar use (functions). They can provide an impression of the morphological situation of the urban area. To cover the objectives of the project – the simulation of the German housing stock -, seven Urban Structural Types were defined. [3] In addition the age of the buildings by statistical data is needed to hitch up information on the different historical building techniques and materials. Representatives of building-types and infrastructure-types containing this information are used as bottom-up empirical data for the analysis of UST.

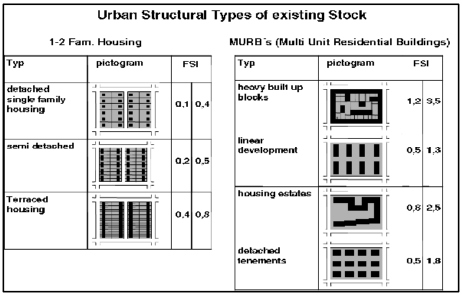

Figure 1. Urban Structural Types

2. Findings

Both scenarios assume that Germany has 82.5 Mill inhabitants in 2000 as well as in 2025. The average floor space per inhabitant is expected to grow from 39,2 m² in 2000 to 47.7 m² (Reference scenario) or 46.2 m² respectively (sustainability scenario), within this period. The total floor space area until 2025 will rise from 3,2 Billion m² in 2000 to 3,9 Billion m² for reference and to 3,8 Billion m² for the sustainability scenario. These "growth" figures indicate clearly, that the sustainability scenario was not artificially set to be an austerity scenario.

A significant difference in the scenarios can be found in the new land take for residential areas. A difference of factor 5 between the scenarios indicates the importance of the municipal land use planning and the challenges to guide towards sustainable development. The net building land take per day will drop from 25 ha per day to 4,5 ha per day in the sustainability scenario. The options to take are more inner city development, less free standing single family homes, recovery and improvement of existing housing stock instead of new construction, re-use brown fields etc.

Therefore the sustainability scenario reduces significantly new land take.

Beside these spatial analyses, the BASiS-2-Modell allows material flow analyses (MFA). In this area the model interlinks with the GEMIS-databank, a primary source for building product data. All building products are listed with their process chain, embodied energy and environmental "emission profile". The scenarios in conjunction with building product data allow to estimate the effects of future building activities along branches or materials. The change in building techniques and products will affect the building industry differently.

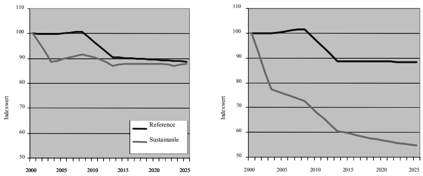

Figure 2. Effects of housing development on the wood- (left side) and concrete-industry (right side) (Year 2000 = 100)

For example will the future slow down in building activities concern the concrete industry in the sustainability scenario far more than the wood industry. Two reasons: The orientation of housing policies towards refurbishment and modernization of the existing stock instead of new housing construction and the assumed higher proportion of wooden instead of massive construction in housing.

With these types of analyses the BASiS-2 model could help the building industry to be well prepared for the future. But attempts to get them involved in long term scenarios (2025) failed, because their time-horizon doesn't go beyond 5 years. "Who knows whether we then still exist." Therefore up until now politicians show the greatest interest in the research finding.

In terms of CO_2-emission until 2025 different scenarios for thermal improvement of existing housing stock were calculated.

In the reference scenario 1% of building envelope of existing stock (sustainability scenario 2%) will be improved per year to meet the legally binding energy regulation of today. In new construction it was assumed, that 5 % from 2005 onward will comply with Passivhouse-standard. In the sustainability scenario the ratio will rise by 3 % annually to 35 % of Passivhouse-construction in 2025. Not only the thermal envelope but also heating systems and national fuel mix were altered in the scenarios to gain a picture of the CO_2-future with regard to building stock in Germany.

In result the CO_2-emissions from future housing stock decreases from 227 Mio tons in 2005 to 107 Mio tons in 2025. This is a reduction of 50 % in the sustainability scenario. The sensitivity analyses show that despite the thermal envelope improvement changes in the heating system (e.g. small district heating) and change of used fuels (less coal and oil, more natural gas, more biomass) contribute most to the reduciton.

All in all, the study delivers a whole range of results and furthermore it can be used by third parties to write own scenarios. For these interested in more details, the study is published, with a short English abstract and can be ordered from www.uba.de.

References

[1] UBA (Umweltbundesamt) (2004) Stoffflussbezogene Bausteine für ein nationales Konzept der nachhaltigen Entwicklung – Verknüpfung des Bereiches Bauen und Wohnen mit dem komplementären Bereich „Öffentliche Infrastruktur". *Endbericht.* Berlin: UBA.

[2] Duhme, F., Pauleit, St. (1999*) Stadtstrukturtypen – Bestimmung der Umweltleistungen von Stadtstrukturtypen für die Stadtplanung.* In: Raumplanung 4 (1999), S. 33-44

[3] Deilmann, C. et al. *Nachhaltige Entwicklung des Wohnungsbestandes in sächsischen Groß- und Mittelstädten.* … Endbericht. Forschungsbericht. Dresden: IÖR, 2001

Procurement in the construction industry: choice models

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The construction industry, even though characterized by differentiation, localism and globalization phenomena, always plays an important role in the economy of a country. At the same time progress, technological innovation, sustainability, greater rapidity in the changes always require, a "quality product", also in the construction sector in terms of product and process, with reference to the context in which it is carried out.
In this light procurement is of extreme importance and, more in general, methods, approaches, systems of relationships between the different actors (stakeholders) involved in the process and, particularly, between clients, designers and contractors. In fact, the procurement route existing number is of great importance, both in the private and the public sector, in different contexts and times developed according to the requirements/requisites of the situation.
Therefore, the present work aims to identify some models - of support to the client - for the choice of the best procurement system, depending on the characteristics of the work to be realized and on client demands.

Keywords: Public Procurement, Private Procurement, Bayesian network.

1. Introduction

In this ambit to speak of "quality product" it means to speak, in particular, of work quality, work costs and realization times. These can be understood insofar as the three fundamental objectives of the building process that interest, above all, the customer that, naturally, desires to get a product of good quality at the correct cost and in congruous times. However the attainment of these objectives can clash with the affairs of other actors, above all if involved according to the traditional approach in which the designers design and the contractors build.

Overcoming this division of affairs, or rather the sharing and profit sharing of this objective, is possible through the individualization of the most opportune *procurement system*. Where by "procurement systems" can be intended the *approaches* (or methods) that allow the definition and regulation of the agreements between the various process actors (*procurement routes*), specifying *what* must be submitted, to *who* is submitted and *when*, the *methodology*, or rather *how* it is submitted, and finally the *objectives*, or rather *why*.

The different existing procurement systems, in fact, are characterized by the combined answers to these five "questions", according to a combination that cannot be casual, but it has to meet the precise demands that characterize the project to be realized. That is to say, define the type of work that the contractor intends to build, and kept account of the surrounding conditions, it is necessary to identify a procurement route and which methodology is best to provide it.

2. The study of existing procurement systems

The existing forms of procurement routes are numerous and vary widely since they were conceived and developed at the time to respond to different market demands, differently characterized according to the context of reference. A first and fundamental characteristic of this market is given by the distinction between the public sector and the private sector, which corresponds to an as important differentiation between the procurement systems used that, despite deriving from same principles, are codified by different rules. In fact, if specific norms do not exist for private sector procurement systems and the only ties are contractual in form, in contrast, in the public sector, defined as *public procurement*, there are precise norms prescribed by special laws.

The *public sector* of the construction industry is part of the wider area of public procurement, which includes supply, works and service contracts, and is characterized, in Europe, by the opening to the single or internal market and by the relative directives, to which all the countries members have to conform. The norms in force in the principals European states have been studied, namely France, Germany, the United Kingdom, Spain and Italy.

In contrast, within the *private sector*, the procurement systems used in Italy and in the United Kingdom have been identified and analysed, as the Anglo-Saxon world is always taken at an international level as a reference or as a model for management systems.

3. Results organization

The studies and especially the critical analyses carried out on the different construction industry around the world, also using interviews with construction firms operating in different European countries, as well as the indications on the possible procurement developments identified by the study of the latest trends in building process management, constitute the ample cognitive baggage of an "expert" that has been used for the creation of the two choice models, one for the public sector and the other for the private sector.

The study of these systems, underlines their connections between the work characteristics and customer requirements/wishes and some procurement "techniques" and/or "procedures". It is therefore necessary to organize all the information collected about these systems, in order to provide a general overview of it and better identify its strengths and weaknesses, understood as aspects that can determine positive or negative effects on the project.

These effects, in terms of the three principal objectives of quality, costs and times, constitute the indications supplied, by the two choice models, to the *decision maker* for the selection of the procurement system.

4. Construction models

Having organized the results obtained, it was necessary to individualize the tool best suited both to represent the context (work characteristics and customer needs/wishes, normative ties) and to manage all the variables used to define the procurement systems. Among the possible techniques, the Bayesian networks have been chosen. In fact, probabilistic type techniques allow the interpretation of the results obtained, and particularly the indications (opinions) of the interviewed experts as the probability that the various procurement approaches are suited to the context in which we operate. The proposed models are interactive because the decision maker can select, in the input nodes, the context properties to choose the best procurement system that is automatically suggested by the output nodes or, alternatively can select a procurement system, or parts of it, to know the context properties.

The need to create two models, one to support the public customer and the other the private one, is due not only to the wish to make the models as simple as possible, in terms of the interface with the end user, but also to the convenience of creating networks with the smallest possible number of connections, therefore eliminating the elements typical of one sector that have no importance in another.

5. Conclusion

Leaving aside the analyses on the current construction market, together with the studies on the latest trends in building process management, the presence of a number of procurement systems has emerged, the characteristics and advantages of which recommend an widening of the choice of systems to apply, rather than restricting selection to a few approaches. From here, the objective to propose two choice models of support to the customer, one for the private sector and the other for the public sector, for the selection of the procurement system that, due to its characteristics, is best suited to respond to the demands of the case. The construction of these models as Bayesian networks, characterized by the representation simplicity of the context and by the interrogation facility of the same, make the proposed models extremely interactive and dynamic, also allowing simulations of events in cases where knowledge of the context is limited. Finally, a further benefit of Bayesian networks and therefore of the proposed models is the possibility to update and improve them constantly through the use of statistical data, coming from "new" experiences, which in this way can be integrated with the "expert baggage" used for their construction. The models have also been built so as to simplify the change of weights attributed to variables that define the performance of the various procurement systems in terms of quality, costs and construction times. In fact, this is the first operation that the decision maker should complete with the aim of "educating" the model to the context of reference, attributing the weights on the basis of his own knowledge and experience. These last two characteristics make the model for the private sector of great interest since it can also easily be adapted to and, therefore, applied in different specific national and international contexts.

Essential bibliography

[01] Albino V., Costantino N., Sivo G., "Le costruzioni: mercato e impresa", ed. Carocci, Roma, 2000
[02] Bennet J., "International Construction Project Management", Butterworth Heinemann, UK 1991
[03] Collier K., "Managing Construction: the contractual viewpoint", Del mar Publishers Inc., USA 1994
[04] Korb B. K., Nicholson A. E., "Bayesian artificial Intelligence", Chapman & Hall/CRC, UK 2004
[05] Morton Ralph, "Construction UK: introduction to the industry", Blackwell publishing, UK 2002
[06] Pearl J., "Probabilistic reasoning in Intelligent Systems: Networks of plausible inference", Morgan Kaufmann Publisher, USA 1993

PPP process models for service provision – PPP performance process model

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PPPs (Public Private Partnerships) have been conducted as a practical form of cooperation between the public sector and the private economy since the 1940s. As science only started focusing on this issue at a much later date, the theoretical design of PPPs and in particular the corresponding processes are extensively unstructured. To reduce the complexity of PPPs and prevent opportunistic attitudes within the partnership, structuring, scientifically based models are needed that can serve as recommendations for actions for the participants of a PPP. Through the application of process models, PPPs can be incorporated into a wider spectrum of public works thus increasing efficiency. With the main objective of structuring PPP processes, this paper presents a PPP performance process model for structuring the functional-operative processes of a service provision PPP.

Keywords: Public Private Partnership, process model, cooperation, street maintenance and rehabilitation.

1. Introduction

Public Private Partnerships are an issue that first gained relevance in practice, before becoming the focus of science and research. The late involvement of science in the PPP development process caused the PPP processes to be extensively unstructured. The task of science is now to supply clear process structures for complex and long-lasting partnerships incorporating scientific theories, thus opening PPPs to a wider spectrum of public works and improving efficiency in future. The Institute for Construction Engineering and Management of the ETH Zurich is developing a process model for the maintenance and rehabilitation of communal street networks in Switzerland, which structures the cooperation between the public and private sectors for a service provision PPP [1].

2. Research methodology

In order to obtain scientific findings in business management issues, the hermeneutic paradigm [2] is being adapted for business and management research, leading, i.a., to the constructivist paradigm. The constructivist research approach aims to structure new socio-technical systems based on an intended input-output relation. The validation of the research project is based on triangulation, whereby the Principal-Agent Theory [3] and Giddens' Theory of Structuration [4] are applied for theoretical reference framework.

3. Definitions

The entire spectrum of public-private cooperations can be structured by the "degree of cooperation" [5]. The degree (intensity) of cooperation is defined using a combination of the "degree of formal institutionalization" and the "scope of tasks of the PPP" (Fig. 1).

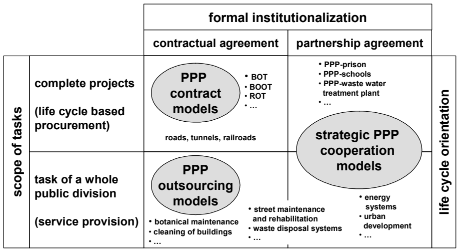

Fig. 1 Distinction among the PPP basic model groups [5]

In terms of their formal institutionalization, PPPs can be split into two forms of contractual agreement:

- Contractual agreements, where the (minimum) two parties stay economically and legally independent.
- Partnership agreements between (minimum) two parties to form a new joint PPP-corporation.

In terms of their scope of tasks, PPPs can be differentiated in (Fig. 1):

- Life cycle based *procurement PPPs* for complete projects, including design, financing, construction and operation phase within a specific public division, and
- *Service provision PPPs* for certain tasks of a whole public division within the operation phase (only); performing services and providing products over a long period of time.

This differentiation provides the three PPP basic model groups (Fig. 1): PPP Outsourcing Models, PPP Contract Models and Strategic PPP Cooperation Models. As the fulfilment of certain tasks of a whole division of the public sector is a characteristic of the service provision PPP, the basic PPP model groups PPP outsourcing models and strategic PPP cooperation models could be applied.

4. Status of research

Existing research approaches mainly focus on the so-called procurement PPPs. To date there are no approaches in literature known in regard to structure service provision PPPs for those whole public divisions. As such, there is a general need to develop both functional-operative and normative-strategic structures for service provision PPPs.

5. PPP process model for maintenance and rehabilitation of communal street network

The overall PPP service provision process model [1] is structured into three interlinked partial PPP process models by the dimensions “phase” and “level of action”. The high integration of the partial PPP partnership process model and the partial PPP performance process model in the performance phase is shown in figure 2. The high interlinked and integrated processes consist of two task categories, the coordination and routine processes (Fig. 2).

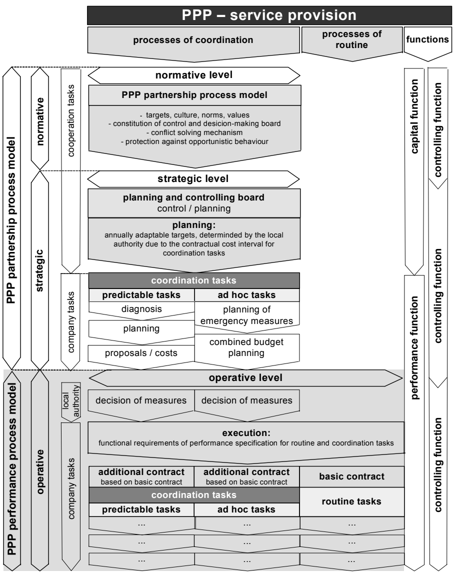

Fig. 2 PPP partnership and performance process models of a service provision PPP

Coordination tasks, which consist of predictable tasks and ad hoc tasks, have to be annually or ad hoc planned by the planning and controlling board on the strategic level within the partial PPP partnership process model. After planning the proposals will be submitted to the public authority for decision making. The PPP performance process model is based (dependant) on the input of the strategic level (PPP partnership process model) in form of the local authority’s decisions that include which coordination tasks should be performed in the actual period. The coordination tasks will be executed according to additional contracts based on the stipulations of the basis contract.

The routine tasks do not need any coordination. For their execution performance and output standards are initially determined in the contract. These standards ensure service performance for the routine tasks on the basis of output standards, such as the cleanliness index and other quality indicators. Following these modalities, the PPP project controlling is guided by the functional tender, which includes functional requirements of performance specification, thus allowing the private partner to choose how to fulfil the specified tasks. The results and the quality of the services need to be assessed by the public sector (or the planning and controlling board).

7. Conclusion

A PPP generates complex processes that can initially hinder their use for the performance of public tasks. The PPP performance process model enables non-opportunistic partnership and cooperation agreements by focusing on the core competencies of the involved players and by structuring the processes.

References

[1] Girmscheid, G. (2005) PPP-Projekt-abwicklungsmodell - Unterhalt von kommunalen Strassennetzen. Bauingenieur, Band 80, 220-227.
[2] Guba, E. G. & Lincoln, Y. S. (1994) Competing paradigms in qualitative research. In: Denzin, N. K. & Lincoln, Y. S. (Eds.) Handbook of Qualitative Research. Sage, Thousand Oaks.
[3] Jensen, M. E. & Meckling, W. H. (1976) Theory of the Firm - Managerial Behavior, Agency Costs and Ownership Structure. JFE, Vol. 3, October 1976, 305-360.
[4] Giddens, A. (1985) The constitution of society outline of the theory of structuration, Cambridge, Polity Press.
[5] Girmscheid, G. & Dreyer, J. (2006) Public Private Partnership - Begriffliche Strukturierung und Modellbildung. Bauingenieur, 81, 99-109.

Technological innovation and life quality in the buildings of XXI century

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One of the main characteristics of the Modern Architecture is the particular attention to the social problems. The "funzionalismo", to the beginning, has had a big spread because the functionality of the architectural spaces was considered a necessary condition for the quality of the life . During the phases of design and construction it is very important a continuous control of the today's requirements in order to the quality of the life.
The collaborative design is a very interesting approach in order to a new way of thinking the architectural design, that includes the today's requirements of the comfort, the energetic saving, the intelligence use of the resources, without to limit the freedom of the aggregation and the composition of life spaces.
The collaborative design research represent a possibility to move away from the professional practice, by promoting the overcoming of a designing method based on independent steps and making it possible to get back to its original meaning, as the expression of a unitary and simultaneous expression of all the involved aspects..

Keywords: Modern Architecture, collaborative design, society.

1. Architectural desig and social requirements

One of distinctive features of modern architecture includes a particular attention with regards to social problems. In fact, a real challenge that the architects had to deal with in the first decades of the 20th century was to be able to face the needs of a new society which required good quality and low cost hygienic spaces for a rapidly increasing population that was making the city dimensions enormous in a very short time; to be able to built hospitals and schools for all, where everyone could find equal assistance and possibility of learning; to create work places, factories and offices, in such way to always safeguard people's dignity and liberty. Finally, it can be stated that these were the most deeply-rooted and profound contents of the Modern Movement, what allowed it to deal with and propose solutions to improve life conditions of today's man.
In the new line of architectural studies it is still observed how a synthesis between form and function that had always shaped architecture of all times suddenly becomes missing: in architecture of the Modern Movement it is the function that needs to prevail, because only in this way it is possible to face up the needs set by the new building types represented by factories, workers' areas and new urban systems.
It's know how from these considerations a dogmatic attitude derived with regards to new architecture, particularly reserved in occasion of the fourth C.I.A.M., which caused a reaction and created a definite breaking after the eleventh and last C.I.A.M., in Otterloo in 1959: a demand for autonomy of architectural form with regards to the function consequently found further supporters.
It's just the case of remembering how from critics addressed to "International Style" and to extreme simplification of language that it was proposing, there arose the stances of "Tendency" movement and its leader, Aldo Rossi, and of vast sectors of architectural culture, not only in EuropeAnd still, as exactly from this annulling Peter Eisenman started to elaborate his deconstructionist theory, tending to liberate architecture from any ties of functional nature. In this way, creativity becomes the dominant category of architect's activity without functional contaminations that the reality can exert on architecture.
Once the relationship between function and form has been put in discussion, with a revaluation of the second with regards to the first, as well as considering that technological evolution hasn't only allowed one greater formal liberty for the most elevated performance characteristics of building materials with consequent minor structural ties, but it necessary implies risks of a poor experimentation of new technologies, a continuous control is now more necessary than ever, in planning and building phases, of respect of essential functional requisites with regards quality levels of life which are today considered unbreakable.
For this purpose, *collaborative design* is used as an essential instrument for planning that takes into consideration the needs of environmental comfort, energetic saving, rational utilising of resources and appliances with limiting the liberty of composition and aggregation of spaces for man's life.

2. The modern needs of architectural design

Today, infact, the architectural design is always more complex.
People hope that technology can increase the level of quality life in home like in town. In the last years, a lot of international research works, are oriented to define a method of design based on innovative computer technology that can be applied also to traditional issues and traditional design methodologies. The scientific starting point was therefore based on multidisciplinary issues, regarding both the process of design and its application purposes.
The general goal is to develop suitable tools in support of integrated Process/Product design activities, to develope a final response to the growing complexity of today's requirements of the design of an architectural work.
The actual complexity of design, in fact, is made increasingly complex by the nature of the architectural product itself, by the number and specialisation of the operators involved, by the increased need to fulfil regulatory, procedural and technical obligations and by the growing availability of products and services.

3. A collaborative approach for Architectural Design

Collaborative design is a process with involves a high interdisciplinary level, de-localisation of activities, division of operations, appropriate timing in the use of information and correct use of the most advanced methods and technology. According to such new approach, computer technology and the engineering of knowledge combine to generate "informative" models of construction, which can develop design methods directly from the constructive practice and procedure. During the last 20 years of the 21st Century, Architects and Engineers have used more and more ICT resources, to manage the complexity of building design.Today, in the collaborative design "dimension", the sharing of the decision-making process is grounded in the use of computer technology. In offices with different specializations, localized in different places, the equipes of designers can work together. Every contribution goes to create a "unicum" model of the project. This model of the project is located in a virtual space: every equipe of designers offers its contribution.

4. Benefits

Designing in collaborative manner, can offers the opportunity to give many control levels for the project.
One of the main lines of development of the collaborative methodology is the possibility to carefully weigh up different solutions during the development of the design, unlike what happens in today's professional practice often gives priority to the first acceptable solution as a basis for later developments, neglecting alternative solutions even if innovative (or especially if alternative) if they involve longer times or higher designing costs.
Thinking at the Modern Movement, In particular, the decay of many works is often the result of poor attention to the complexity of design, which often leads to the adoption of inappropriate technological solutions, sometimes even because it is impossible to simultaneously compare them with other solutions that seem t involve higher building costs in the short term, without looking however at the benefits that they would provide in terms of durability and therefore in terms of maintenance costs.

5. Conclusion

The develope of Collaborative design aims to:

- To promote not only the mere application of computer technology to architectural and building design (which can however be still essentially "juxtaposed"), but to test the possibility that they may become second nature with it, from simple tools to the implementation of working methods, able even to affect the genesis of a potential transformation of the designing concept and practice.
- To find potential relations with the tradition of design. Design has always had an essential meaning: to be a "verified concept".
- In the past, 'concept verification' was implied in designing and building to the professional standards that had been developed by tradition over the centuries.
- Now the design concept is verified before erecting the building, according to the modelling of its building features, through an interaction of the many disciplines involved and an iteration between the time of conception and the time of verification.
- To assess, with reference to the proposed applications, how the implementation of building models can get to guide the practice of design itself.
- In order to incraese the quality of life in the buildings, the need to develop, alongside the theoretical models, practical applications tools for studying modelling procedures for non-standardised building elements looks now particularly interesting.

BygSoL – Learning at the building site

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For more than 20 years different initiatives have been carried out to increase the productivity of the Danish Building Industry. However, the longer lasting results of these have not yet materialised. This paper presents a development initiative in the Danish Building Industry called BygSoL. The focus of BygSoL is learning and cooperation at the building site supported by implementing elements from among other things Partnering and Lean Construction, and by offering educational programs at the building site. It is claimed that by involving a broad range of representatives in the sector and at the same time having focus at the building site, the initiative points in the right direction for making longer lasting development of the building process.

Keywords: development initiative, workforce training, empowerment, action research

1. Introduction

The BygSoL initiative (Danish abbreviation for Cooperation and Learning at the Building Site) emerged as a response to the lack of long lasting effects of earlier development initiatives. Instead of trying out new ideas, the focus of BygSoL is on implementing existing concepts by shaping and combining the concepts according to the requirements of the specific building project. The objective of this paper is to present the BygSoL initiative and the provisional findings with focus on how elements from the initiative counteract the sub-optimisation among trades at the building site. Furthermore, challenges in the initiative will be discussed with the aim to show that there is still room for improvement. The authors have been involved in BygSoL in several ways: at building projects as action researchers, in the research team and as consultants.

2. Presentation of BygSoL

The BygSoL initiative started primo 2004 and is joined by the labour-market parties, technical universities, technical colleges and schools, companies and 10 building sites of varying sizes. The objective of BygSoL is to make the building process more effective, efficient, and safe by supporting learning and cooperation activities at the building site. However, instead of developing new concepts, BygSoL focuses on implementing existing concepts and on using the knowledge emerged from the former development initiatives, which showed great potential. The core of BygSoL is three elements:
- Lean Construction [1],
- Partnering [2] and
- Learning at the Building Site [3].

3. The structure of BygSoL

The working structure of BygSoL, which carries out the practical tasks, consists of three parties, which mutually depend on each other. Most important is the building projects where elements of Lean Construction, Partnering and Learning at the Building Site are implemented. The support to the design an implementation plan and the actual implementation is provided by involved technical colleges, technical schools, supplementary training centres and the project secretariat. The educational courses undertaken at the building site are designed to meet special needs at the specific building project. The Knowledge Program is a group of researchers and consultants who on daily basis work with topics relevant for developing the building process. The Knowledge Program's objective is to provide the building projects and educational institutions with relevant updated knowledge. Beside this, the Knowledge Program helps evaluating the building projects and thereby obtain input to new research.

4. Typical elements of BygSoL

Even though each building project in BygSoL is unique, and a special implementation plan is made for each project, there are some common characteristics:

- An introduction meeting with all participants in the project
- A noon-to-noon seminar with an introduction to the building project, teambuilding, determination of some common guidelines for the cooperation, and social events in the evening/night.
- Weekly meetings between the sub-contractors and main-contractor to plan the work 5 weeks ahead.

- Weekly meetings where the foremen and/or tradesmen plan the work one week ahead;
- Training activities planned in relation to the state of the building project, the training could e.g. be a supplier showing the correct installation method of the heating system, or the training could be guidance in safety-practice.
- A common room or temporary workmen's shed for breaks and meetings for all the tradesmen and the site manager(s).

5. Provisional findings

Some of the building projects have formally been evaluated using surveys and interviews [4]; others have informally been evaluated using observations and informal interviews with the participants. The provisional findings include:

- The cooperation between the trades have improved significantly at BygSoL-projects compared to former building projects.
- The noon-to-noon seminar has a big influence on the atmosphere at the building site.
- The common room is a success for information dissemination between trades and has also affected the atmosphere towards being lighter and more trustful.
- The tradesmen also find the involvement in work planning very useful and it gives them knowledge of why certain decisions are made. However, this demands the managers to be open and to bring the ideas and decision made by the tradesmen in action. At some building projects this has been a problem.
- Most of the participants find that BygSoL has a positive influence on their learning.

In a broader view, the provisional results of BygSoL are mainly personal relationships and initiation of networks. Individuals from various professions, both practitioners, educators and researchers, have formed personal relation ships. Through these relationships knowledge and experiences disseminates informally as an alternative to formal knowledge disseminations at e.g. conferences or in evaluation reports. These interdisciplinary relationships can in the future help to support a more coherent educational system, where the apprentices and students are educated to handle the challenges in the building industry, not only the methods and knowledge of the specific profession, but also interdisciplinary communication and coordination.

By placing the educational programs at the building site and in the context of the daily practical work, the tradesmen see the learning activities as a natural part of their work-life, and the tradesmen contribute to making the building process more Lean. By bringing the tradesmen together in interdisciplinary planning tasks and educational programs, the tradesmen get at broader view on the building process to avoid sub-optimization, and the tradesmen are better equipped to be changing agents at subsequent projects.

However, there are still some challenges that need to be dealt with in order to fully exploit the potential of the tradesmen's knowledge. The role of the manager should be redesigned to fit the new circumstances and the managers should get the needed support in order to handle the situation.

References

[1] Ballard,G. (2000) *The Last Planner System of Production Control*.

[2] Bennet, J. and Jayes, S. (1998). The Seven Pillars of Partnering. Thomas Telford Publisihng.

[3] Elsborg, S., Dam, A., and Bertelsen, S. (2004). *BYGLOK - A Danish experiment on cooperation in construction.* Conference Proceedings IGLC14

[4] Teknologisk Institut. Slutevaluering af BygSoL - implementeringen på DPU (2006). BygSoL/ Teknologisk Institut (in Danish).

Learning about the building process

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Production delays are often due to lack in communication and coordination between different trades. However, these problems seem to reoccur on projects even though the industry is aware of them. This paper seeks an understanding o, why it is so difficult for different trades to cooperate and communicate to develop the building process. To clarify the causes for lack in communication and coordination, syllabi and former research on the tradesmen's perception of learning is analysed and discussed.

Keywords: workforce training, learning, tradesmen, building process

1. Introduction

Recent research shows that the reasons for frequent delays in the production process are related, among other things, to issues regarding communication, organisation and planning of work, [1]. As the reasons for production delays in the building process are clear, it might seem an easy task to eliminate them. However, knowledge and skills generated within a project do not transfer smoothly to other projects or to the main organisation [2]. While most argue, that the solution to improving learning and development lies within a reorganisation of the building industry to support longer lasting strategic co-operation, this paper seeks an understanding of the problem within the current conditions and framework.

2. Definitions of learning

The paper is inspired by communities of practice (COP) [3]. In this paper COP is used as a notation for a group of individuals participating in a shared practice and having a shared history or repertoire and thereby sharing identity of how to be a practitioner. When the shared knowledge or image about practice is challenged, negotiations in the group reconstruct the meaning in accordance with the new knowledge. Unlike COP, project practice tends to be non-repetitive and time bound, and it is often loosely coupled to multiple organisational contexts through subcontracting or supply chain relations. Project work generates learning not through repetitive activities in a stable context, but rather through the intensive integration of different forms of knowledge within a novel or uncertain and temporarily bounded task setting [2].

3. The tradesmen's learning

The knowledge used by the practitioners in building projects to perform their job is to a great extent tacit and gained through experience, and they learn by watching and imitating. They use episodic memory (stories of episodes) instead of semantic memory (abstract interpretation). Competences are, according the practitioners from the survey, an inborn talent mixed with practical experience in contrast to theoretical knowledge learned in training institutions. [4]. This perception of learning tallies with the way COP operates and learns. But this inhibits learning across trades and in unstable contexts such as in the project organisation. Looking through the syllabi of education programs as well as supplementary training programs one strong common feature comes into mind: the inwards focus. All programs isolate the students from other professions. The syllabi show, that almost no programs include subjects like cooperation and getting an understanding of the building process as a unified whole, etc. The programs do not provide apprentices with an image of the constraints between the different professions or an understanding of the mechanisms that put together the different professions' knowledge and skills in the building process. Instead the focus is on own methods, own skills and specialist knowledge relevant only to the profession concerned.

4. "Us" and "them"

Due to the strong inward focus in the educational systems, individuals have a strong image of "us" and "them". Us-relations are between people who, to some extent, have the same educational background and thereby the same image of work practice. Them-relations are between people with different professions and educational background. This causes the communication to be limited to explicit work instructions. Because of the lack of continuity in them-relations, there is no inborn trust in the relations, but there are expectations of the different roles.

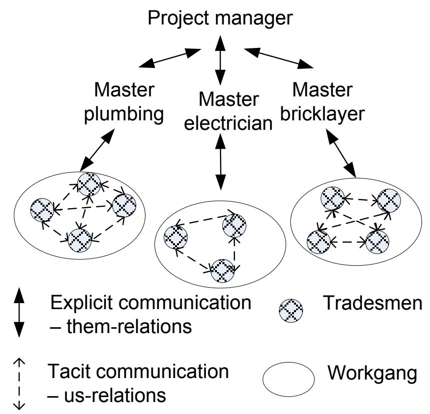

Figure 1 "Us"- and "Them"-relations in a project organisation.

In the building industry, most practice is divided into sub-contractors, which work on their own. This means that learning at project level is typically based on knowledge integration activities, which involve overcoming, rather than deepening, division of practice among project members [2]. However, the temporary organisations inhibit long term relationships. This cause the participants to refer to the different professions or roles (them) that are more or less stable from project to project instead of referring to the individuals. Due to the changing structures for co-operation, the participants do not have the same image of practice, and thereby the communication at project level is mostly explicit. This limits the depth of learning to the explicit agreement of how the project went, and mostly there are no such agreements because the members disperse after completion of a job-task.The workgangs on the other hand are the stable units continuously refining their practice. But the workgangs' focus is mostly inwards on own methods and experience. Even though their practice is highly dependent on other professions, they tend to work in isolation from the other professions. If they adjust to the other professions it could be characterized as an ecological adjustment [5], which is an adjustment to the other professions with the aim of stabilizing own practice as a survival mechanism. Seen in a broader perspective, the ecological adjustment is a sub-optimization and does not lead to a better building process.

Conclusion

In project organisations in the building industry learning happens at two levels; the workgangs and the project organisation. The workgang focuses on own methods and with the aim of improving own effectiveness and profit. At project level learning is limited and also with an inwards focus for each sub-contractor. In the light of this it is no surprise that most learning at building projects causes a deepening of the division of practice and sub-optimisation.

References

[1] Alpegren, S., Richter, A., and Koch, C. (2005) Snublesten i byggeriet. R-107Byg DTU.
[2] Scarbrough, H., Swan, J., Laurent, S., Bresnen,M., Edelman,L. & Newel,S. (2004) *Project-Based Learning and the Role of Learning Boundaries. Orgnization studies*, 25, 1579-1600.
[3] Brown, J. S. & Duguid, P. (1991) *Organizational learning and communities-of-practice: Toward a unified view of working, learning and innovation. Organization Science*, 2, 40-57.
[4] Bønnelykke, M. (2003) Kvalitativ undersøgelse af byggeriets udførende virksomheders læring og behov for videnformidling for Fonden Realdania. Alsted Research A/S.
[5] Argyris, C. & Schön, D.A. (1978) *Organizational learning a theory of action perspective*. Addison-Wesley Publishinng Company.

Development of an indicator system for construction logistics

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Logistics on construction sites becomes more and more important. Since the planning of construction logistics on many major sites is practised daily, the challenge is to control the planned processes on site. The staff on site has no reliable method to check the logistic in- and output of the construction logistics. This lack of information and the related problem, that mistakes can't be analysed correctly, is the reason, why many logistics concepts fail in detail. People return to established processes and miss the chance to make the supply chain more effective. Therefore, this abstract takes a first step towards an indicator system for construction logistics. It provides a short overview about the use of logistic indicators in general and deflects indicators for construction logistics. Sources for information and obstacles are briefly discussed.

Keywords: Indicator System, construction logistics, material and equipment management, supply chain management

1. Performance of construction logistics

Starting from a sound preparation of work, different working fields can be identified for the performance of construction logistics. In the case of big projects, it will be useful to plan these topics in the preliminary stages to get the maximum use out of the logistic concepts. Planning parallel to the constructing period – regrettably still being practised in Germany – is insufficient from a logistic point of view and therefore has to be refused. As for all planning services in construction, it is also true for expert planners being involved at an early stage, can the decisive fields be effectively influenced. The increased planning effort and the surplus costs connected on the side of the client are disposed to a higher reliability in view of costs, time and quality in the construction realization. The logistic concepts can be roughly divided into supply logistics to the construction site, site logistics as well as disposal logistics.

2. Scientific approach: Indicators in logistics

Indicators serve for demonstrating quantitatively comprehensible facts of business administration in a concentrated form. They can refer to the entire enterprise (e.g. balance indicators) or they can be applied for single departments and divisions (e.g. production or logistic indicators).

The most important elements of an indicator are its informative character, its ability to be quantified and the specific form of its information. The latter referring to complicated structures and processes being shown in simplified form to allow a rapid and complex overview especially for leading authorities.

Indicators have to fulfil criteria determined for practical use covering inquiry, controlling and recipient. The inquiry of indicators has to be based on the data available and that they can be recorded with little effort, use-orientated and for the long term. For the control with indicators it has to be considered that they are target-related, relevant for control, influenceable, resistant against manipulation and incentive-orientated. Last but not least, they have to be understandable, definite and interpretable for the recipient so that they can be used as database in process control.

3. Novelty: Construction logistic indicators

A number of logistic indicators can be transferred to construction logistics without further adjustment. In several fields considerable differences become obvious. Especially obvious is the deviation in the sector of distribution logistics. Due to the immobility of the product, this field is completely inapplicable in construction logistics. It's place, with limitations, is taken by disposal logistics which has direct influence on the logistic processes at the construction site. However, the structure of the indicators in this sector is deviating from the systems of supply and construction site logistics so that only a few indicators can be applied for the superordinated indicator system. Within the planning phase there are different information sources available for the determination of indicators. Applications of CAD (Computer Aided Design) and AVA (Ausschreibung, Vergabe, Abrechnung – application of tenders, allocation, invoicing) are of special importance for data processing in the construction sector. These systems contain a great deal information which – with an appropriate classification – provides clues about the logistic need at the building site. In the process planning the data are being used already for the dimensioning of transport and storage capacities. However, the evaluation is mostly done manually and without planning and controlling system. A documented control and performance calculation is not made so that further sources for the determination of indicators are not available.

In logistics, therefore, technologies as barcodes and RFID for identification are decisive for a continuous data flow which, in the end, should comprise the entire logistic process. The necessary databases for storage are so-called WMS and ERP systems. A realization of the process optimisation over several suppliers up to the final customer is therefore called supply chain management. So the target is to establish these technologies, systems and management approaches and to link them with already existing planning programs to simplify the planning and control of the logistic service.

To meet the requirements of the criteria for the use of indicators an automation of the recording at construction sites is indispensable. Special need of research lies in the low-effort identification of the items and the continuous availability of the data. Here, technologies as barcodes and RFID tags as well as software applications from the group of WMS/ERP are of special importance. For those responsible at the construction site their application has to be realized without any problem and with low effort. In consequence communicating control measures and incentive systems will become understandable for the recipient and clearly representable with the aid of the indicators.

4. Conclusion

The application of indicators is widely spread in logistics control of the stationary industry. The advantages provided by this approach can also be transferred to the construction industry. Also in a construction enterprise the target is the optimization of the rentability, of the economic effectiveness and of the productivity.

For this target, however, the development of a logistic indicator system is necessary to fulfil the requirements of a construction site on the one hand. On the other hand, the data recording and data management has to be automated to be able to easily and user-friendly care for the system. Currently the efforts supporting this step for the construction industry become obvious from the side of the WMS and ERP providers.

References

Reichmann, T. (1995) Controlling mit Kennzahlen und Managementberichten, 4. Auflage, Verlag Franz Vahlen, München, Germany

O'Brien, W. J., London, K., Vrijhoef, R. (2002) Construction Supply Chain Modeling: A research review and interdisciplinary research agenda, In Proceedings IGLC-10, Aug. 2002, Gramado, Brazil

Salazar, G., Mokbel, H. Aboulezz, M., Kearney, W. The use of the building information model in construction logistics and progress tracking in the Worcester Trail Courthouse <http://www.icccbexi.ca/program/Abstracts/tp154.pdf> Rev. 2006-06-25

Zou, P.X.W., Seo, Y., (2006) Effective applications of e-commerce technologies in construction supply chain: Current Practice and future improvement, In Proceedings ITcon Vol. 11 (2006) pg. 127-147

Jang, H., Russell, J.S., Yi, J.S., (2003) A project manager's level of satisfaction in construction logistics, In Canadian Journal of Civil Engineering Vol. 30, 2003

Bronsted, J., Walloe, P., Bindslev, K. (2003) Object oriented information modelling for use in lean construction, In proceedings International Group of Lean Construction, 11th Annual Conference, July 22 - 24, 2003, Virginia Tech, Blacksburg, Virginia, USA

Salagnac, J.-L., Yacine, M. (1999) Logistics: A step towards lean construction, In Proceedings: Seventh Annual Conference of the International Group for Lean Construction (IGLC-7) Berkeley, California, USA, 26-28 July 1999

Veiseth, M., Rostad, C.C., Andersen, B. (2003) Productivity and logistics in the construction industry, In Proceedings Nordnet 2003, Project Management: Dreams, Nightmares and Realities Oslo, Norway September 24-26, 2003

Ala-Risku, T., Kärkkäinen, M., (2004) Material delivery problems in construction projects: A possible solution, In International Journal of production economics <http://lib.tkk.fi/Diss/2005/isbn9512277654/article5.pdf> Rev. 2006-06-25

Whole life costing in the building industry: a case study

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The importance of whole life costing (WLC) appraisal in the design and management of buildings has long been recognised within the construction industry. WLC estimation considers alternative design solutions in terms of cost and other performance measures such as sustainability which is increasingly becoming an important issue to clients. This paper reports on the process of WLC estimating and describes its application in a case study that compares the whole life costs for different types of windows over their whole life cycle. The results indicate that despite higher initial costs the whole life costs of timber windows are significantly lower than uPVC windows over a life cycle of 60 years. The paper also highlights the difficulties in the application of whole life costing as a decision making tool in the construction industry.

Keywords: Whole life cost analysis, WLC process, theory of significance, FMEA, RCM.

1. Introduction

Whole life costing is not a new approach, but its implementation is becoming much more important as long-term building owners and clients start to demand evidence of what their costs of ownership will be [1]. More private companies are investing in the Private Finance Initiative (PFI), Public Private Partnership (PPP) projects, and the increasing Government demand to concentrate on reducing WLC [2] all contribute to its growing importance. This paper reports part of an EPSRC funded research project carried out by the University of Dundee. The aim of the research project is to develop a generic approach to minimising WLC in the construction industry. The purpose of this paper is to describe the steps of WLC processes which are based on the application of the "theory of significance, and to demonstrate its application through a case study.

2. WLC process

Flanagan et al [3] suggested that application of WLC for every element in every project is time and resource consuming, so there is a need to find a way of simplifying its application. One possible solution is to apply WLC technique only to significant elements, which have been shown to be those whose WLC is greater than average [4]. The WLC process developed in this involves the following steps.

1. Identify all anticipated building phases and activities that will generate cost in the life cycle.
2. Create or adopt WLC data structure.
3. Identify potential cost drivers – WLC significant elements.
4. Determine the data required to estimate each alternative option.
5. Select method(s) for estimating costs of each alternative option.
6. Estimate WLC of each alternative option.
7. Compare various alternatives.
8. Evaluate results for uncertainty and risk.
9. Compile WLC for the whole building.
10. Report findings and conclusions.

3. What comprises a successful WLC analysis?

Optimised through life solutions require an integrated team approach to development of a project. Whilst achieving a solution which is within the client target cost and affordability, it is important that other client objectives (political, functional, operational, sustainability, commercial, etc) are met. The principal purpose of WLC analysis is to provide facilities management data to designers in order to select the design solution that satisfies the required level of availability and performance with the lowest facilities management cost. To do this accurately, it is necessary to understand factors such as location, context, operation scenario etc that influence project costs, and to collect actual data about frequencies (replacement, planned preventive maintenance, cleaning, etc) and performance, energy consumptions, etc.

4. Case study

The WLC process was implemented using the steps described in the previous section on a high school project for 1050 pupils, and the data breakdown structure developed by El Haram et al [5]

The WLC of the 29 elements used in the original design were estimated using data from standard estimating books. Eleven WLC significant elements were identified, whose total costs were higher than the average WLC for all building elements. The demonstration of the practical application of the process is based on one WLC significant element, “windows”.

Three alternatives were selected: high quality softwood, aluminium and uPVC. Failure Mode and Effect Analysis and Reliability Centred Maintenance (RCM) tailored for construction by El-Haram and Horner [6] were applied to identify the required maintenance tasks. Operating costs related to windows were identified in terms of cleaning. The cleaning costs of WLC significant elements were estimated using recommended frequencies of cleaning.

The WLC analysis of the three different types of double glazed windows shows that the NPV at a discount rate of 3.5% for 60 years can vary between the cheapest WLC option and the most expensive by about 30% [7]. Although uPVC windows are the cheapest to install they are the most expensive in terms of WLC. A sensitivity analysis for discount rates (e.g. 3.5% and 6%), economic life (e.g. 30 and 60 years) and various physical life expectancies was carried out. The rank order of the NPV of each of the three alternatives was insensitive to changes in the variables.

5. Conclusions

The WLC process developed in this work has been applied to a practical example. The identification of WLC significant elements is based on “the theory of significance”. This “theory” is a powerful tool for defining the WLC significant elements for each building type, and can help to reduce the collection of data needed for detailed WLC analysis. For example, in the high school used in this analysis, 38% of all elements contributed 82.4% of total WLC. The WLC process should integrate the use and sharing of data related to project design, construction, operation and maintenance costs and encourage closer working relationship between members of the construction industry supply chain to make the best decisions from the WLC point of view. The WLC process should be used for analysis and reduction of WLC in early design stages (e.g. scheme design). Further analysis on different types of buildings will be carried out in order to check the consistency of occurrence of WLC significant elements. If such a consistency is found, the effort required to estimate WLC can be reduced by some 70%.

Effective estimates of WLC and improvements in accuracy will come about as a result of improvements in the WLC process, integration of supply chain, education and training, use of proper tools and techniques, provision of sufficient resources and time and a good reliable cost database. It could be several years before the construction industry has enough data from which better estimates of WLC can consistently be made.

References

[1] Egan J. (1998). Rethinking Construction. Report of the construction Task Force to the Deputy Prime Minister, DETR, UK.

[2] Construction Productivity Network (2000) “Whole Life Costing - The New BS/ISO Standard”, Report of a Joint Workshop with the Housing Forum, Bristol: CPN Report, UK.

[3] Flanagan R., Green L., Garnett N. and Fisher N. (1999) Cost of ownership through integrated logistic support. Project Summary Report, unpublished report, The University of Reading, Department of Construction Management & Engineering.

[4] Horner R. M. W. & Zakieh, R. (1996) "Characteristic items - a new approach to estimating and controlling construction projects". *Construction Management and Economics,* **14**, 241-252.

[5] El-Haram M. A., Marenjak S., and Horner, R. M. W. (2002) Development of a Generic Framework for Collecting Whole Life Cost Data for the Building Industry. Journal of Quality in Maintenance Engineering, MCB University Press, 8(2), 144-152.

[6] El-Haram M., and Horner R. M. W. (2002) Practical application of RCM to local authority housing: a pilot study. Journal of Quality in Maintenance Engineering, MCB University Press, 8(2), 135-143.

[7] Marenjak, S (2004) A Generic Approach to Minimising Whole Life Costs in the Building Industry. PhD thesis, Department of Civil Engineering, the University of Dundee, UK.

Innovative solutions for emergency architectures

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A technology for the construction of temporary buildings with low environmental impact, costs and construction efforts, that can be used as modular architectures in emergency situations. The materials used for roof, walls and floor is a corrugated cardboard. It's a product that results from a recycling process and is itself recyclable. The new proposed technology opens new perspectives for the management of natural catastrophic problems (earthquake, floods ...), allow thinking in an innovative way the understanding of house for emergency residence.

Keywords: sustainability, recycling, low costs, easily transportation and assemblage

1. Paper and recycling

As it is well known, papers are the major support for writing that have contributed and still contribute, to the spread of knowledge and communication between civilizations. However, the transformations that papers undergo through years have rendered them a poured material and made them enter in different contrasting fields trades. The corrugated cardboard, is one of these transformations that allowed the use of papers in the field of packing (standard boxes, larger boxes, etc). It has been this introduction to boost the idea of studying new and innovative uses, such as containers for objects and for persons leading to a strong stimulus for architecture use. Nowadays, recycling is not considered anymore as a strange idealistic fantasy, but rather a civil habit. The recognition of this fact has contributed with no doubt to push towards further research of new technological and technical solutions in various fields that involve materials of high degree of recycling as the corrugated cardboard exactly is.

2. The modular system

Papers and corrugated cardboard are not exactly material for construction. Raw materials, as well as production process, have a great influence on the final material performances. However, that does not mean that the main concepts of engineering cannot be applied in this case. To construct with the paradigm of reversibility, is one of the concepts taken in consideration to face this research, which means facing the principles that make a practical fact the inversion of the constructive process: from production to divestment to "the zero residual" according to the sustainable development. Considered as a possible equilibrium between resources and their environmental impact. the better way to reach the objective of transformation-adaptation and of the reversibility of the construction operations, is to dry assemble the construction without any nails, hill or other additives use. It is not of our objectives to create or to invent a new material that constitutes a real overcoming of the currently available alternatives, but rather a new way of using the potentialities of an already available material, not only of product but also of process, and to combine them together. After several efforts and trials to conceive an element composed of corrugated cardboard that could combine itself in a modular way creating a wall system as well as a cover and an attic, than do not reflect a simple large box, a prototype has been developed that resolved a great part of the problems related to the above cited constructive systems. The final configuration of the modular element is obtained from the juxtaposition of two corrugated cardboard sheets adequately folded in a U shape, obtaining in this way a carrying structure of a squared, quarry, closed and crushproof implementation, of equal sides of 25 cm, able to support a significant compression effort up to 461,4 Kg. This construction has zones that can hold lateral break-through and with bended moments, to absorb these effects. Their weight is around 863g and the block dimensions after its assemblage are of 50x50cm of plant and 40cm of height. This measures guaranty a precautionary degree of stability. For static ends, the solidification of the elements occurs by "combination" and not by "cohesion". When exposed to water or to excessive humidity, the cardboard tends to soften as a result of the hydrogen links disintegration that are established during the fabrication process of the sheets. This disadvantage can be avoided, or at least attenuated using particular charges within the production process that makes the cardboard humid-resistant; or by applying to the cardboards already produced, films of polyamide material. The application of these products, beyond improving the hygroscopic and impermeable property of the corrugated cardboard, they improve its resistance and rigidity. Moreover, the fire is not cardboard's best friend. Therefore, to make our material fireproof or at least try to delay its ignition, it is possible either to insert directly in the mill a particular type of charges, or to apply a fireproof paint that could result in more complicated recycling of the cardboard.

3. Uses

The structures that result from the assemblage of the modules in corrugated cardboard turn out to be light, resistant and quick to realize. The simple and easy transportation and use of these corrugated cardboard make the product appropriate for demonstrations in fairs, expositions and most of all to each the main objective of this search and to build units for emergency habitations. The modularity of the system allows the creation of various raised and plant configurations, succeeding in constructing blocks of adaptable dimensions to every type of space. The rapidity of assembling all elements allows transporting them in single pieces, collecting the sheets in pile and consequently resulting in a remarkable increase of the cargo ability and therefore in a greater number of transportable elements. As a practical application, of this proposed system, a series of demonstrative set-ups of prototype unit of inhabitation were made. As an immediate result, the attention has been turned to the emergency cases, that consist in the use of this system for setting-up emergency shelters. In this way the times of realization will be lowered and albeit will be possible to transport greater number of inhabited units. The modular system allows the realization of structures that can be organically transformed and adapted in function of the user's requirements and needs. These constructions can be taken apart and rebuilt many times until the total recycling at the dismissing time. As to what concerns the lightings and the natural aeration, they are achieved through windows replacing some cardboard modules corrugated with others, the alveolar polypropylene, an impermeable and easy workable material is proposed in this case.

4. Scope and expectations

The final scope of this work is to achieve successfully structures fully composed of corrugated cardboard, avoiding environmental contamination and additive materials uses and resulting economic, sustainable and of low environmental impact. Structures that may be both temporary or permanent reflecting the following characteristics:

- the assemblage of the modules is done without any additives or particular fixing materials (glue, nail, and others...)

- the strength of this structure is due to it form rather than the material of construction, it is resistant towards the static stresses

- the residence can be easily built, even an singular person can assemble it by simply reading the instructions

- does not present constraints in the spaces characteristics as the assemblage could be realized in a different architecture as needed

- allows enteric comfort performances such as the traditional material building

- does not need any particular foundations

- materials transportation presents an advantage of 1:3 comparatively to the other available solutions

The development of this research requires time and investments exactly as all the materials that have a main role in the construction fields. One of the most important objectives is to obtain through this research, waterproof and fireproof cardboards from the initial productive cycle. All project considerations were developed taking in consideration that further research should be done on the static behaviour of these structures and the consequences due to extended exposition to sunlight and weather condition.

Womens' entry in to construction: Does industry culture act as a barrier?

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The construction industry is male dominated industry in UK. Women face numerous difficulties to entry in to the construction industry. This problematic nature of the construction work place and its impact on women entry into industry formed basis for a significant lower participation of women in the industry construction industry.. This paper critically reviews the literature on whether industry culture affects women entering into the field and if so, how and why.

Keywords: Barriers, Construction, Culture, Women.

1. Women in construction

The role of the women in employment is changing fast in most societies and as mentioned earlier in Britain women constitute just over half of the total work force. However as per the [1] it was revealed that women still constitute only 9% in construction sector.Women now comprise some 18% of the undergraduates on construction related courses within the UK[2]. The UK construction industry is busier now than it has ever been for a decade and is suffering from skill shortage in both craft and manual trades such as bricklaying, plumbing and painting, and at the professional level, in engineering, quantity surveying and estimating[3]. [4] noted that construction workplace has been described as amongst the most chauvinistic in the UK, with an extremely macho culture and hostile and discriminatory to women. In that context this paper critically reviews the literature on whether industry culture affects women entering into the field and if so, how and why.

2. Barriers faced by the women in entering and progressing in construction

Within the number of studies detailing the position of women in construction, the studies related to problems faced by the women to enter and retain in the construction industry could be considered as important. It is mainly the barriers, which lead to a lower participation rate of women in construction. Therefore, it is vital to look into the problems faced by women entering into construction. There are several barriers for women entering and working in the construction industry. From the literature survey the major barriers have been identified as image of the industry, career knowledge, culture and working environment, family commitments, male dominated training course, and recruitment practices .

3. Construction organization culture

Within organizational theory the concept of culture tends to be used in two distinct ways: firstly as something that an organization has, that can be construed as an independent variable; and secondly, as something an organization is, a root metaphor [5]. A number of writers [6] describe culture as having different layers. [7] envisages three levels of culture: first artifacts, which includes observable behavior and processes as well as physical objects; second, publicly espoused value such as mission statements and policy documents; and last the underlying assumptions which are rarely articulated and may conflict with espoused values and even with each other. Many companies with espoused "women friendly" policies may be exposed by women's lack of progress compared to their male colleagues, an artifact in [7] terms.

4. Discussion

Literature findings highlighted that construction companies provide a patriarchal work place environment, where men resent women's participation as professional equals [4].further, they highlighted that gender appears to be embedded within the practices and relationship that construction organization endorse, as the synergy of the exclusionary and discriminatory aspects of the industry's subculture challenge women's success and avert their participation. The cultural create an orderly set of rules. They aim to remove cognitive and behavioural dispositions, which deviate from the norm, and to ensure that employees adopt the organization's values as their own behaviour in pursuit of career goals [9]. In particularly, work hours and staff allocation were organized in an erratic and ad – hoc manner, which had created difficulties for women with life-cycle restraints [10]. According to [4] reaching powerful senior operational positions have proven particularly problematic for women, because in addition to socially excluding them, men appear to overtly attempt to undermine women's contributions in an attempt to preserve their own positions. This provided the proven of cultural conflict exists between environment offered by the construction workplace and women's career needs expectations. [10] has highlighted competitive work environment as a reason, where mangers were in a contest for a limited number of promotional opportunities. Further, she identified that this situation had been intensified by companies continuing to appoint externally to middle management positions, and by the removal of management levels in order to streamline organizational structures. This resulted in women being perceived as a threat, both in terms of promotional opportunities and to existing cultures [10]. This resentment was manifested in overt discrimination and harassment and informal discriminatory mechanisms. These latter mechanisms included excluding women from out of work events, which offered career enhancing benefits.

5. Conclusions

This paper has provided a Critical review and analysis of literature on barriers, with particular focus on industry cultural aspects affecting entry of women into construction industry. Culture of construction has been highlighted by many researchers as the one of the major barrier for women, beginning with difficulties in joining the field of construction till capturing the top most position in the organisation's hierarchy. Organisations' recruitment practice is not fair for women's progression in the industry. Therefore this culture environment is problematic for women unless it changes such a way that their contribution is welcomed by the construction industry.

References

[1] Construction Industry Training Board (2003), Construction Skills Forecast Report [Online] Available from: http://www.citb.co.uk [Accessed September 2004]

[2] HEFCE, (2001) Applicant to degree courses at university or college, London

[3] Whittock, M. (2002) Women's experiences of non traditional employment: is gender equality in this area a possibility?, *Construction Management and Economics*, 20, Pp 449-456

[4] Bargilhole B.M., Dainty, A.R.J. and Neale, R.H.(2000) *Women in the construction industry in the UK:A cultural discord?*, Journal of women and minorities in science and Engineering,Vol.6,pp73-86

[5] Smircich,L.(1983) *Concepts of culture and organizational analysis*, Administrative Science Quarlty,Vol.28,pp 339-358

[6] Newman,J.(1995) Gender and culture change, in Itzin,C. and Newman,J.Gender culture and organizational change, Rutledge, London

[7] Schein, E.(1992) Organizational culture and leardership,2nd ed.,Jossey-Bass, San Francisco,CA

[8] Hofstede, G. (1991) Cultures and Organizations: Software of the Mind, McGraw-Hill, London

[9] Baron ,R.A., and Greenberg, J.(1990) behaviour in organizations: understanding and managing the human side of work,Allyn and Bacon, Boston, MA

[10] Bagilhole, B.M.(2003) *A comparative analysis of professional women's and men's careers in the UK construction industry*, ESRC publication

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Client-led do as I say, don't do as I do – Discrepancies between clients' advice and their procurement behaviour

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During recent years, traditional procurement procedures have been criticized for being outdated and unsuitable, due to the trend towards increased complexity, uncertainty and time pressure in construction projects. Thus many call for a change in order to achieve procurement procedures more compatible with project reality. The purpose of this paper is to compare an empirical investigation of Swedish construction clients' recommendations regarding procurement procedures with another investigation regarding Swedish construction clients' current procurement behaviour and discuss any discrepancies between these investigations. The empirical data shows large differences between procurement recommendations and current behaviour. In an advisory situation, clients mostly recommend the establishment of relationships based on cooperation, instead of traditional "arm-length" relationships. The current procurement procedures actually used, however, facilitate competition rather than cooperation. Hence, there seems to be a classical "Do as I say, don't do as I do" situation.

Key words: Partnering, procurement, cooperation, governance
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1. Introduction

Traditionally, construction procurement decisions are often judgmental and subject to biases of the decision-maker [1]. It is however important that such decisions are made logically, systematically, and in a disciplined manner [2], considering the nature and characteristics of the project. According to transaction cost theory (TCE) the transaction characteristics asset specificity, frequency/duration and uncertainty should determine how to procure and govern a certain transaction in order to facilitate efficiency.

In many western countries the construction industry is often criticized for lack of cooperation, generating problems regarding both costs and quality [3]. During recent years the interest for more collaborative relationships, mostly referred to as partnering, has increased as an alternative approach to traditional procurement and project governance. However, so far the increased interest has not yet resulted in a broad adoption of the concept [4, 5]. In Sweden, the positive arguments for partnering are mostly raised by construction contractors. Most people however agree that such changes should be initiated by clients through their procurement and project management processes. The purpose of this paper is threefold. First, to present an empirical investigation of Swedish construction clients' recommendations regarding procurement procedures in different project contexts in order to explore if a change towards more cooperative procurement processes are called for by the clients themselves. Second, to present survey regarding Swedish construction clients' current procurement behaviour in order to explore if a

change towards more cooperative procurement can be identified. Third, it aims to compare clients' recommendations with current practices and discuss any discrepancies between them.

2. Procurement's effect on cooperation

Construction projects mostly involve complex and customized transactions with high frequency and/or long duration coupled with high uncertainty. From a TCE perspective, they should therefore be governed within a relationship focused on cooperation. A suitable balance between cooperation and competition is facilitated by proper procurement and governance [6]. The choices made during the procurement process will involve three different types of control; output, process and social control. Output control can be achieved through contractor specification of the product (design and build contract) and fixed price compensation, facilitating competition. Process control can be achieved through client specification of the product and reimbursement compensation. These procedures are more difficult to relate to either competition or cooperation but detailed design coupled with comprehensive monitoring is argued to be detrimental to cooperation [7]. Social control can be achieved through joint specification, incentive based compensation and collaborative tools, facilitating cooperation.

3. Empirical results from Study 1

In order to study how different project types and the actual set of other preconditions in connection to a project are affecting the contracting model a field survey was carried out by Toolanen [8] in Sweden. 32 professional clients agreed to act as advisors in different contracting situations. The respondents advise that traditional arm-length relationships are not very suitable in any project situation. High uncertainty, short lead times, lack of bidders, and high complexity and frequency further increase the need for cooperation. The advice therefore suggests that clients should establish cooperative relationships with contractors. Design-bid-build approaches were recommended only for slow, certain and simple projects and when there was risk for few bidders. In other situations design-build contracts were considered more appropriate. The use of transparent remuneration forms including incentives (cooperation) were mostly recommended by the respondents in cases with complicated decision environment, while fixed prices were only considered suitable in slow, certain and simple projects.

4. Empirical results from Study 2

The quantitative data was collected through a survey sent to 104 Swedish construction client organizations which are members of a national construction client association (Byggherreforum). 87 responses were received, representing a response rate of 84 percent. In this study clients' current procurement procedures were investigated. It was shown that the clients specify the product thoroughly (Design-bid-build) before they procure contractors based on fixed price. Joint specification and incentive based compensation are seldom used. Furthermore, collaborative tools, such as joint objectives, shared IT-database, joint project office and teambuilding, are not commonly used during project duration.

5. Conclusions

In this paper clients' advice regarding suitable degree of cooperation (Study 1) has been compared to clients' current procurement procedures (Study 2). The empirical result of Study 2 shows that construction clients make choices during the buying process rendering in governance forms that facilitate a focus on competition in the transaction relationships. These empirical results do not fit the recommendations of the respondents in Study 1. They recommend some degree of cooperation in all project contexts, arm-length relationships are never considered most suitable. Additionally, increased complexity, uncertainty, frequency and short lead times further increase the need for cooperation. Hence, there seems to be a classical "Do as I say, don't do as I do" situation. According to TCE, transaction relationships between construction clients and contractors should have a higher focus on cooperation than on competition, due to high complexity/customization, long duration and high uncertainty. The cooperative advice given in Study 1 therefore seems more suitable than the competitive behaviour observed in Study 2.

6. References

1. Cheung, S.-O., et al., An Analytical Hierarchy Process Based Procurement Selection Method. Construction Management and Economics, 2001. 19(4): 427-437.
2. Love, P., M. Skitmore, and G. Earl, Selecting a Suitable Procurement Method for a Building Project. Construction Management and Economics, 1998. 16(2): 221-233.
3. Egan, J., Rethinking Construction. 1998, Department of the Environment, transport and the regions and HMSO: London.
4. Kadefors, A., Trust in Project Relationships - Inside the Black Box. International Journal of Project Management, 2004. 22(3): 175-182.
5. Ng, T., et al., Problematic Issues Associated with Project Partnering - The Contractor Perspective. International Journal of Project Management, 2002. 20(6): 437-449.
6. Eriksson, P.E., Coopetition in Buyer-Supplier Relationships: How to Obtain a Suitable Balance between Cooperation and Competition through Proper Procurement and Governance. Under review in Scandinavian Journal of Management, 2005.
7. Korczynski, M., The Low-Trust Route to Economic Development: Inter-Firm Relations in the UK Engineering Construction Industry in the 1980s and 1990s. Journal of Management Studies, 1996. 33(6): 787-808.
8. Toolanen, B., Målstyrning i Byggprocessen Genom Val av Genomförande-, Ersättnings- och Samverkansformer, in Department of Civil and Environmental Engineering. 2004, Luleå University of Technology: Luleå.

Client-led subcontractor involvement – A way to increase value creation and innovation?

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In spite of their importance, clients and main contractors seem unaware of that subcontractors can bring added value to the construction process. Due to competitive tendering procedures and the transactional focus the relationships between main contractors and subcontractors are mostly adversarial, resulting in a lack of supply chain integration and collaboration, which is negative for value creation and innovation. The purpose of this paper is to investigate how construction clients' procurement procedures regarding subcontractor selection and involvement affect value creation and innovation in construction projects. The tentative case study result shows that the client's procurement procedures affect the level of subcontractor involvement and integration, but that this does not necessarily results in increased subcontractor value creation and innovation in the construction process.

Key words: Supply chain integration, partnering, procurement, subcontracting

1. Introduction

One prominent characteristic of the construction industry is the practice of subcontracting portions of a project to specialty contractors (subcontractors) by general (main) contractors [1]. Traditionally, the relationships between main contractors and subcontractors are often characterized as strained by conflict and mistrust, derived from traditional procurement procedures based on price [2]. The lack of integration and collaboration between these actors is negative for innovation and value creation. Hence, to facilitate incremental improvements and innovation the skills of suppliers and subcontractors should be assessed and utilised through an integrated supply chain [3]. The purpose of this paper is to investigate how construction clients' procurement procedures regarding subcontractor selection and involvement affect value creation and innovation in construction projects. The empirical data has been collected in a case study regarding a construction project in Sweden.

2. Innovation in construction

One of the key notions within the construction innovation literature is that successful innovation often requires effective cooperation, coordination and working relationships between the different parties involved in specific projects [4, 5]. Aspects of traditional and non-partnering procurement that can hinder the ability of subcontractors to innovate and contribute to innovation include the division of work, contract conditions and allocation of risk.

To address these problems and improve the potential for subcontractors to contribute to innovation there are several procurement aspects to consider. First, an extension of partnering relationships to subcontractors, that is, a broad partnering approach is recommended. In addition, early involvement of subcontractors can increase their motivation to propose and initiate innovations in particular projects [6]. The possibility of successful innovation is increased dramatically when there is fair sharing of risk between parties and minimal contractual and statutory constraints to innovation [5]. In addition, construction contracts can also be designed on a win-win basis to include incentives and rewards for all participants involved in innovation. To further increase the integration of different actors and create a collaborative project climate "collaborative tools" should be utilised throughout the project duration [7].

3. Case study

A case study investigated how the client's procurement procedures affect subcontractor involvement and if and how such involvement affects value creation and innovation in a construction project. The case study regarded procurement and subsequent construction of a plant for the manufacturing of pharmaceutical products in Sweden. The case study data was collected through interviews, case surveys to all participants in the partnering team, document studies and also observation and participation in a large amount of meetings and workshops. The case study followed an action research approach in which the first author served as an advisor/facilitator to the partnering team. The client used several techniques to integrate the different actors and create a collaborative project climate: a broad collaborative approach, early procurement not based solely on lowest price, contracts based on joint profit sharing, suitable risk allocation and various collaborative tools. The participants argued that these techniques functioned rather well in this project and that they resulted in increased subcontractor involvement and integration. However, their involvement only led to small improvements in their contributions to innovation. There are a few possible reasons for these results. First, it may be derived from the fact that the client failed to create a project climate that encouraged the actors towards innovation and continuous improvements. Second, subcontractors' contribution to innovation depends to some extent on collaboration with consultants, which was somewhat problematic. Third, this increased integration enhances knowledge sharing and incremental learning which may be hard to utilize in the short-term during the duration of a single project.

4. Conclusions

The empirical results show that the client can increase subcontractor involvement and integration by purposeful procurement and project management procedures, such as early procurement not based solely on lowest price, contracts based on joint profit sharing, suitable risk allocation and various collaborative tools. These procedures are often important parts of partnering processes but they often concern only client and main contractor. In the case project, however, these processes also included important subcontractors through the client's broad collaborative approach. However, this study also shows that involvement and integration can be beneficial in many ways but it does not necessarily result in increased innovation and value creation, which depend on many other factors. In the case project the actors failed to create a climate that encouraged innovation and continuous improvements. Furthermore, relationships between design consultants and subcontractors need to be strengthened in order to increase subcontractor impact on design. By adopting a long-term perspective, however, the client can learn from these shortcomings and improve these aspects in future projects. It should also be beneficial to let project participants working together over a series of projects in order to reap the benefits of increased knowledge sharing and continuous learning. In this way increased innovation and value creation can then be obtained through a long-term perspective on subcontractor involvement and integration.

5. References

1. Eccles, R., Bureaucratic versus Craft Administration: The Relationships of Market Structure to the Construction Firm. Administrative Science Quarterly, 1981a. 26(3): 449-469.

2. Miller, C., G. Packham, and B. Thomas, Harmonization between Main Contractors and Subcontractors: A Prerequisite for Lean Construction? Journal of Construction Research, 2002. 3(1): 67-82.

3. Egan, J., Rethinking Construction. 1998, Department of the Environment, transport and the regions and HMSO: London.

4. Gann, D. and A. Salter, Innovation in Project-Based, Service-Enhanced Firms: the Construction of Complex Products and Systems. Research Policy, 2000. 29(7-8): 955-72.

5. Ling, F.Y., Managing the Implementation of Construction Innovations. Construction Management and Economics, 2003. 21: 635-49.

6. Dulaimi, M.F., F.Y. Ling, and A. Bajracharya, Organizational Motivation and Inter-Organizational Interaction in Construction Innovation in Singapore. Construction Management and Economics, 2003. 21: 307-18.

7. Eriksson, P.E., Procurement and Governance Management - Development of a Conceptual Procurement Model Based on Different Types of Control. Management Revue, 2006. 17(1).

Decision support tool for payment selection mechanisms for construction projects

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Payment systems in construction are always dealt with in isolation to the procurement system. Procurement approaches are changing to reflect the new climate of trust and co-operation. As a result there is a new need emerging that calls for a cash flow model that promotes integration and early project based planning considering the potential payment system. This is one of the fundamental principles behind the research of this paper.
This research aims to investigate and make explicit the advantages of applying appropriate payment system by developing a decision support tool that links payment systems to the project plan. The proposed model has to be capable of analysing alternative payment mechanisms from a supply chain perspective. This will define the payment system in terms of the four layers involved, namely "the process map", "the supply chain", "the pricing method" and "the payment method". This paper, as a result of this research, presents the principles of a decision support tool developed to assist industry practitioners to select the most appropriate payment system for given sets of project requirements and characteristics.

Keywords: Payment mechanisms, cash flow, construction process

1. Introduction

This paper aims to model payment systems for the UK construction industry and promote their use as performance enabling mechanisms. Payment systems in this context relate to the processes by which construction products and services are priced and paid for. The research will focus on approaches that will encourage best practice and help facilitate project stakeholder satisfaction.

The proposed model aims to investigate and make explicit the advantages of applying appropriate payment system by developing a decision support tool that links payment systems to the project plan. This paper presents the proposed model which assist industry practitioners to select the most appropriate payment system for given sets of project requirements and characteristics.

2. Research background

The literature reviewed has shown that choosing the appropriate pricing and payment system can have a positive effect on the management and delivery of a building project and, ultimately, the quality of the finished building product. Each system is appropriate for a specific project and client circumstance. Even the traditional methods of the lump-sum and unit-price have their usefulness for the appropriate project and client circumstance such as when there is adequate information to produce a complete design, thereby, allowing proper contractor competition, reduce tender cost, easy assessment of interim valuations and variations for payment, and comparatively low final project cost and higher level of certainty that quality and functionality standards will be attained (Masterman 2002, Smith 2002 and IChem 2003).

Williams (1992), O'Reilly's (1993), Potts (1995) and Smith (2002) have all categorised types of contracts by the types of payment systems. Contracts that specify 'lump-sum' and wholly 'cost-reimbursable' payment are acknowledged by IChemE (2003) to be the extremes of a wide range of forms of contract that provide for the allocation of risks and responsibilities between the contracting parties. There is a variety of forms of payment which IChemE (2002) lists as: reimbursable cost-plus a percentage-fee; reimbursable cost-plus a fixed-fee; target cost (shared over-run and/or under-run); unit-rate (including re-measure guaranteed maximum price; lump-sum services and materials with reimbursable construction; lump-sum (i.e. wholly lump-sum)

3. Process map

The "process map" defines the products, services, management, design, engineering, and prefab & assembly needed for a project. Having a process map enables the project team to agree on a common framework for managing and controlling a project in order to meet the client's business needs.

Many process maps have been developed to represent construction projects. Among the well known maps to practitioners in the UK, there is the architect's plan of work (RIBA 2000) and the Process Protocol (1998), which are adopted for this research to simulate a construction project. Table 1 shows the main phases of a project as classified by the two maps. The developed model contains also details on

4. Pricing and payment systems

One of the main aims of this research is to develop an integrated project team cash flow model that would assist in realising Latham's vision of a less diputatious industry.. The model, at this stage, will use the process maps discussed above and enable users to customize these maps depending on the conditions of the project. When the user is not familiar with the adopted maps, s/he can create a map which is most relevant to the project conditions. A full project program will then be generated using a project management tool. MSProject was linked to the developed model to simulate all relevant data required to obtain the necessary cash flow profile for the client, contractors, and all supply chain members.

At this stage of the model development, three payment mechanisms were fully simulated; namely: the payment system for fixed price contracts, cost reimbursement contracts, and incentive contracts. The model is also able to simulate different payment methods within these payment mechanisms, namely: interim payment (e.g monthly payment), stage payment (when certain milestones are defined for payment), and mobilized advanced payment.

The model has the ability to implement what-if analysis by changing any data elements and finding out the effect on the output. Changes can be made for the cost/duration of any process in a project and also for any payment conditions such as payment delay, payment retention, and the amount of advanced payment. Therefore, the most suitable payment mechanism can be defined considering the project conditions.

5. Conclusions

The progress control and promote satisfaction. The construction indsutry suffers from a high level of bankruptcies and voluntary liquidations due to the problematic issue of cash management. The developed model for this research can help predict cash flow patterns in different payment mechanisms which may result in reducing bankruptcies, thus enhancing the quality of the personal and professional lives of those directly and indirectly involved. Also a considerable number of disputes are linked to problems in payment, hence an integrated project team cash flow model would assist in less diputatious industry. The model will be used by projects' stakeholders to forecast and plan their cash flow once a payment mechanism is defined. The model provides a decision aid tool for representing alternative payment mechanisms in addition to the financial output needed to support the practitioners' assessments.

6. References

IChemE (2003). *Form of contract: target cost contracts* - the burgundy book, first edition. Rugby.

Masterman, J.W.E. (2002). *An introduction to building procurement systems*, second edition. London: Spon Press.

O'Reilly, M.P. (1993). *Principles of construction law*. Essex: Longman Group UK Ltd.

Potts, K. (1995). *Major construction works: contractual and financial management*. Harlow: Longman Group Limited.

Smith, N.J. (ed.) (2002). *Engineering project management*, second edition. Ames, IA: Blackwell Science.

Williams, K. (1992). *Civil engineering contracts* - volume 1: the law, administration, safety. West Sussex: Ellis Horwood Limited.

Safety health environment quality (SHEQ) education and training in South Africa

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The White Paper 'Creating an enabling environment for reconstruction and growth in the South African construction industry' identified the need to improve performance relative to safety, health, environment, and quality (SHEQ) and proposed a range of interventions. The paper reviews the extent and effectiveness of SHEQ education and training in construction management programmes at Universities of Technology. The findings indicate that curricula do not adequately address SHEQ, educators are not familiar with SHEQ related issues or needs of industry, and industry co-operative education role players do not focus on SHEQ during experiential training.

Keywords: safety, health, environment, quality, construction management, education, training.

1. Introduction

Arguably the four aspects of a construction project that require the attention of any construction or construction project manager are construction safety, health, environment and quality (SHEQ). Given that people are the most important resource and their health and well being are important in terms of corporate social responsibility and their ability to work, then health and safety (H&S) are critical. With respect to the environment, activities relative to and their impact thereon, are regulated by a plethora of environmental legislation. Furthermore, many H&S and environmental issues are interrelated. Quality, which is generally defined as "conformance to requirements", is a traditional project parameter. However, conformance to requirements includes H&S and environmental requirements. Furthermore, rework, which arises from non-conformance to requirements impacts on the environment as a result of the disposal of solid waste to landfill sites. The paper investigates the delivery of SHEQ education and training by Universities of Technology.

2. Review of the literature

The Department of Public Works [1] cites inter alia, the following as the key approaches towards enhancing industry performance: quality and productivity improvement programmes; procurement-related measures to promote H&S and environmental protection, and the establishment of best-practice performance standards, partnering and participative management techniques. Smallwood [2] surveyed general contractors (GCs) and members of the former South African Institute of Building (SAIB) to determine the extent to which construction managers (CMs) should be familiar with 75 subject areas. The SHEQ related findings in terms of rankings and mean percentage affirmative responses were: quality management was ranked joint first (98.9%), H&S was ranked joint fifth (97.2%), and environmental issues were ranked forty-fifth (72.7%). Given that the mean affirmative responses were above 50%, CMs should be familiar with SHEQ subject areas. Anderson [3] attributes the non-improvement in the UK construction industry accident rate to seven factors, inter alia, lack of education and training. Anderson maintains that management education and training, particularly that provided by tertiary institutions, "fails to give the necessary emphasis to the subject, and those new to the industry have to fall back on 'learning on the job' as opposed to gaining experience on the job." Smallwood and Haupt [4] advocate a paradigm shift relative to the status of H&S, namely from the view of H&S as a priority to the view of H&S as a value, as values remain constant whereas priorities change. Furthermore, they argue that H&S education will have a direct impact in the form of an improved H&S culture. Smallwood [5] investigated GC perceptions and practices relative to the environment in the Cape Peninsula, South Africa. Based upon the practices and the frequency thereof, he concluded that all tertiary built environment programmes should address the environment. A further study conducted among GCs in South Africa by Smallwood [6] investigated the extent to which twenty-one agencies could improve or contribute to an improvement in quality performance. Management commitment predominated, followed by training, and education. However, education and training are a pre-requisite for awareness, which in turn is a pre-requisite for management commitment.

3. Research

The sample stratum consisted of the Heads of Departments of Building at twelve Universities of Technology. The survey was conducted by means of a questionnaire circulated electronically, and then per facsimile. Despite the aforementioned and subsequent follow-up telephonic requests only six responses were received, which equates to a response rate of 50%.

The traditional project parameters of cost, quality and time are more important than project safety, which is followed by public H&S, environment, and project health in descending order of importance to the Departments of Building. The ND Building and BTech (Construction Management) programmes generally address quality, project safety and public H&S more than project health and the environment. Generally, project safety, project health, and quality are addressed more as a module in the subject Construction Management programmes, than the environment. Project safety and quality are refered to substantially more frequently than project health and the environment in terms of reference thereto in other modules / subjects. However, neither of the SHEQ components is afforded subject status. In general, lecturing staff are perceived to be more familiar with project safety and quality, than project health and the environment. The lesser status afforded project health and the environment is acknowledged in terms of the perceived need to focus more on project health and the environment in both the ND Building and BTech (Construction Management) programmes. However, there is also a perceived need for more focus by industry relative to all the components of SHEQ, but more so relative to health and the environment. Although the BTech (Construction Management) programme addresses the integration of SHEQ more than the ND building programme, the level of integration is inadequate. This is possibly attributable to the lesser extent to which project health and the environment are addressed. The industry is perceived as focusing more on safety and quality during post diploma / post graduate training, than on health and the environment. Therefore, the following can be concluded: safety and quality are more important than health and the environment to both Universities of Technology and the industry; the lecturing staff at Universities of Technology, and industry practitioners are less familiar with health and the environment, than safety and quality. There is a need for lecturing staff to be educated in SHEQ, especially health and the environment. Similarly, industry practitioners need to be empowered through continuing professional development (CPD); the extent to which health and the environment is addressed at Universities of Technology is inadequate; Universities of Technology contribute to the perpetuation of the passé paradigm of cost, quality and time being the primary, or sole project parameters, and Universities of Technology acknowledge the SHEQ related shortcomings in their programmes.

References

[1] Republic of South Africa (1999) *White Paper: Creating an Enabling Environment for Reconstruction, Growth and Development in the Construction Industry*, Pretoria.

[2] Smallwood J.J. (2000) Practicing the Discipline of Construction Management: Knowledge and Skills. In *Proceedings of the 2nd International Conference of the CIB Task Group 29 (TG29) on Construction in Developing Countries Challenges Facing the Construction Industry in Developing Countries*, Gaberone, Botswana, (University of Botswana, Gaberone), 60-70.

[3] Anderson J. (1999) Construction Safety: Seven factors which hold us back. *The Safety & Health Practiti*oner, August, 16-18.

[4] Smallwood J.J. and Haupt T.C. (2000) Safety and Health Team Building. In *Construction Safety and Health Management*, edited by Coble R.J., Hinze J. and Haupt T.C. (Prentice-Hall Inc., Upper Saddle River, New Jersey), 115-144.

[5] Smallwood J.J. (2002) Construction and the environment – General contractor perceptions and practices. In *Proceedings 1st International Conference Creating a Sustainable Construction Industry in Developing Countries*, Stellenbosch, South Africa, (Division of Building Technology, CSIR, Pretoria), 155–164.

[6] Smallwood J.J. (2000) *A study of the relationship between occupational health and safety, labour productivity and quality in the South African construction industry* [Unpublished PhD (Construction Management) Thesis, University of Port Elizabeth].

Evaluation of the maturity level of construction workers in the civil sector - building sub-sector

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The present study has the objective of evaluating the maturity level of workers of the civil construction sector through a case study carried out in a construction site in the city of Florianopolis - Brazil. A bibliographic review was conducted followed by the design of questionnaire, aimed to the preparation of interviews with workers and their supervisors. Among the main conclusions of this study it was found that: (a) there is a big degree of variability between the workers in terms of maturity; (b) the site manager has a central role in the development of the maturity of workers, and for this reason he must have a position of leadership and more qualification; and (c) there is a potential application of situational leadership in the construction site due to the big variability of maturity found in the site under analysis.

Keywords: Maturity, Situational Leadership, productivity.

1. Introduction

The construction sector is the option for who doesn't obtain another work. Generally, these workers believe that an informal learning is sufficient for the kind and quality of work done. In spite of knowing the workers deficiencies, this situation is reinforced by companies that don't demand qualification neither educational level in the moment of employ [1]. The low educational level and deficient qualification are generally pointed as a cause of low productivity and high indices of losses and reworks on construction activities. There is an increasing preoccupation in localize and conserve good workers, because the number of workers without qualification have increased on the last years. Notwithstanding, this workers are not trained to execute their activities. They learn the profession by means of observing the skilled workers [2]. In this context, the present paper pursuit to evaluate the workers maturity level of a construction company, in agreement of the level classification proposed in the Situational Leadership Theory of Hersey and Blanchard [3], in order to assist the development of the maturity level of the workers.

2. Situational leadership

Hersey and Blanchard [3] presents the Situational Leadership Theory, about leadership effectiveness synthesizing the humanistic theories. Blanchard and Hersey characterized leadership style in terms of the amount of direction and support that the leader provides to the followers. They categorized all leadership styles into four behavior types, which they named S1 to S4 (Directing, Coaching, Supporting and Delegating). Of these, no one style is considered optimal or desired for all leaders. Effective leaders need to be flexible and adapt themselves according to the situation. The right leadership style will depend on the follower, in accordance to maturity level, based on the competence and commitment of the followers, named M1 to M4 (Low Competence and High Commitment; Some Competence and Low Commitment; High Competence and Variable Commitment; High Competence and High Commitment). Maturity levels are also situational. Blanchard and Hersey said that the leadership style (S1 - S4) of the leader must correspond to the maturity level (M1 - M4) of the follower. Furthermore it is the leader who must adapt, not the follower. To get the most of situational leadership, a leader should be trained in how to operate effectively in various leadership styles, and how to determine the maturity level of others.

3. Research method

This item represents the path followed during the realization of this research. According to Yin [4], the development of the method is the best tactics to increase the confidence in the research, having the objective of guiding the researcher during his work. The strategy used in this work consisted in a case study with quantitative approach, descriptive/exploratory study, realized in a construction site in the city of Florianópolis, chosen to take part in research projects by GestCon – Administration of Construction Group of UFSC. With the aim of achieving the proposed objectives, the work was divided into three phases:

(Phase A) Bibliographic revision of the literature and creation of a questionnaire to define the structure of the interviews;

(Phase B) Case study that was structured in three stages:

Random selection of workers in the site and structured interview with each of them;

Structured interview with the supervisor (site manager or engineer) of the workers interviewed in the previous stage (1), with the aim of identifying the leadership style utilized with every worker.

Application of the Form for Evaluation of the Manager in accordance with Hambleton *et al. apud* Hersey and Blanchard [3];

(Phase C) Evaluation and discussion of the results.

4. Results

Ten functionaries of the firm were interviewed, one site manager, one carpenter, four brick layers and four brick layer helpers. The results show that the schooling level of the functionaries of this firm is low. Among the interviewed workers, 30% studied up to the 4th series and 70% covered the studies completing between the 5th to the 8th series. Nobody managed to start the high school. It can be observed that, generally, the younger functionaries have a higher schooling level. However, due to their young age, they do not have a lot of experience in the area, usually occupying the role of helper. It is also possible to observe a great variability of time of employment, which has a direct connection with the age of the workers. This shows that the sampled workers started to work in the construction sector at around the age of twenty, remaining in this field until now. The maturity of each functionary was evaluated by his supervisor. The site manager assessed the carpenter, the helpers and the brick layers. His evaluation was then performed by a construction technician that works directly with him. An interview was also carried out with the functionaries, based upon a questionnaire, aimed at identifying their maturity. Is possible to observe that the functionaries evaluated show different levels of maturity, varying from low to moderately high (M1 and M3). Functionaries with high level of maturity (M4) were not identified, except for the evaluation of the site manager. However, it was verified that the site manager utilizes only the leadership style S2, that is, serious job and serious relationship. Acting like this, he obtains good results, once that S2 is an intermediate style between S1 and S2. However there is a tendency to prevent the evolution of workers with higher maturity. These facts demonstrate the application potential of Situational Leadership in civil construction with the intention of developing of the maturity of the workers. A certain amount of discrepancy can be observed in comparing the evaluation obtained through structured interview with the evaluation performed by the site manager that, in most cases, evaluates the workers in higher levels compared to the previous evaluation. Possibly personal relations of friendship and esteem or even accidental existing conflict may cause distortions in the evaluation carried out by the site manager.

5. Conclusion

Through this research it was found that a big variability of maturity exists among the construction workers studied, varying from M1 to M3 according to the classification of Hersey and Blanchard in Situational Leadership. The leadership style utilized by the site manager is always of S2 (presenting high degree of leadership and high degree of support). It was not observed any action of the site manager aimed at the development of maturity of the workers. The site manager presents a schooling level very low. In a general way it can be said that: (a) there is a big variability of maturity among the workers studied; (b) the site manager performs an essential function for the development of the maturity of the workers, for this reason he must have a leading profile and higher qualification; (c) it is necessary to raise the degree of schooling and offer qualified training to the workers of civil construction; and (d) there is a potential of application of situational leadership in the construction site due to the big variability of maturity found. Thus, future studies about this topic are going to be of great value with respect to the contribution and suggestion of creative ideas to the introduction of Situational Leadership in construction sites.

References

[1] Barone, R. E. M. (1998) Canteiro-Escola: os embates presentes na educação do trabalhador da construção civil. *Anais do Congresso Latino Americano Tecnologia e Gestão na Produção de Edifício: solução para o terceiro milênio*, São Paulo, 1998, v.1, p.209-218.

[2] Yankov, L. and Kleiner, B. H. (2001) Human resources issues in the construction industry. *Management Research News*, 24 (3), 101-105.

[3] Hersey, P. and Blanchard, K. (1988) *Management of organizational behavior: utilizing human resources*, 5th ed., Prentice-Hall, Englewood Cliffs, NJ.

[4] Yin, R. K. (1994) *Case study research: design and methods*. SAGE Publications, London.

A review of system dynamics and its potential application to the UK construction sector

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This paper introduces a research project entitled Sustained Competitiveness in the UK Construction Industry. The project's aim is to develop and implement an integrated strategy that supports sustained, innovation-based competitiveness. To achieve this, future Construction Industry trends are being identified together with an investigation of the construction industry's structure. To model the interconnectivities between the structure and these trends, it has been proposed to use a modelling technique called System Dynamics. The purpose of this paper is to provide a historical background to the development of System Dynamics in order to raise awareness of this technique and the appropriateness of its application to construction.

Keywords: System Dynamics, Industrial Dynamics, Urban Dynamics, World Dynamics, Competitiveness.

1. Introduction

This paper introduces a research project entitled, Sustained Competitiveness in the UK Construction Sector: a Fresh Perspective and also provides a historical perspective to a modelling technique called System Dynamics that has been selected for use on the project. The project is being undertaken by the IMRC research centres at the University of Salford, the University of Loughborough and the University of Reading. Currently research is being undertaken to explore future industry trends and how these inter-relate with each other and with the structure of the Construction Industry. This will enable future scenarios to be developed and considered in relation to the current competitiveness context. For example, in recent years there has been a structural shift within the industry to move towards management and coordination functions [1]. It could be concluded that this move towards service provision has impacted the technological skills base of the sector. This shift has occurred within the industry and is affecting its internal structure. The Industry is also changing to embrace external factors such as the requirements of the future needs of the UK economy and society at large that were first introduced in 1999 in the HM Government's Sustainable Development Strategy [1]. The themes introduced in this document have recently been updated in the Securing the Future (2005) report [3]. In this report, Tony Blair states, "Make the wrong choices now and future generations will live with a changed climate, depleted resources and without the green space and biodiversity that contribute both to our standard of living and our quality of life. Each of us needs to make the right choices to secure a future that is fairer, where we can all live within our environmental limits. That means sustainable development." Therefore, in order to sustain its competitiveness, the Construction Industry requires a sustainable environment in which to operate.

2. Introducing system dynamics

In order to understand the internal interconnectivities within the industry and the external interconnectivities between the industry and its environment and how these inter-relate a methodology exists called System Dynamics, which enables systemic interconnectivity to be modelled and analysed. System Dynamics has been selected as a modelling technique for this project, due to its capability to model systems with the purpose of improving behavioural understanding of the system. The Construction Industry and its wider environment are considered to be complex in terms of their components and inter-relationships. System Dynamics offers a technique that models these components and inter-relationships in a methodological rather than *intuitive* fashion. The early methodological phases of System Dynamics modelling share similarities with case study methodology. Initially they both gather and organise information from the actual case. However the case study leaves the information in a descriptive form whereas System Dynamics takes the information and simulates it to reveal the variety of dynamic behaviours that result from different policy choices.

System Dynamics is described by Runge [4] as the "Science and Engineering of Dynamic Systems". It is a science in that it strives for increased understanding of the relationships between structure, parameters and behaviour of dynamic systems. It is engineering in that it strives for greater control or management of dynamic systems.

The System Dynamics modelling technique was developed by Professor Jay Forrester of The Sloan School of Management. During discussions with GEC regarding demand and supply fluctuations, Forrester started to use pen and paper to simulate these discussions in terms of inventories, employees and orders. This system enabled decisions to be made on how many people to employ in the following week, thus allowing a new condition of employment inventories and production. These simulations indicated that the potential for instability within a system was often internally determined. Even with a steady flow of incoming orders employment instability could occur as a result of the policies affecting decision making. Forrester commented, "that first inventory control system with pencil and paper simulation was the beginning of System Dynamics" [5] and was outlined in Industrial Dynamics [6] which was perhaps the first text to outline the philosophy, the mathematics and the computer modeling that was required in order to take a new and pragmatic approach to the management of social systems. Forrester presented Industrial Dynamics as a "way of studying the behaviour of industrial systems to show how policies, decisions and structures are interrelated to influence growth and stability" and ultimately, "how information and policy determine the character of an organisation." The work proposed integrating the previously separate management functions of marketing, research, investment, personnel, production and accounting in order to refocus organisational activity towards the fundamental areas of money, orders, materials, personnel and capital equipment. These five flows are integrated by an information network.

The work was made possible by advances that had occurred in the twenty years prior to publication. Forrester considered these advances to be:

- The development and the advancement in the theory of information feedback systems.
- The fact that decision making had been studied and investigated in the context of military tactics.
- The fact that the experimental model approach to designing complex engineering and military systems can be now applied to social systems.
- The digital computer.

Whilst working at MIT Forrester considered the dynamics of urban environments that led to Urban Dynamics [7]. The scope broadened for the next study, in his 1971 work called "World Dynamics" [8], in which exponential growth was considered in relation to five major trends: Accelerating industrialisation, Rapid population growth, Widespread malnutrition, Depletion of non renewable resources, Deteriorating environment. This work was one of the key influences of the Limits to Growth [9] project that was initiated by the Club of Rome.

3. Conclusion

This paper has presented a brief background to the modelling technique that is System Dynamics in order to stimulate discussion and debate as to the applications this technique may have for the Construction Industry. It is felt that the technique is appropriate for modelling construction as it is particularly adept at modelling complex entities. For the Sustained Competitiveness in UK Construction project, the technique will be capable of modelling and simulating the trends and structural factors that are identified to produce scenarios. These scenarios will provide an insight into the Construction Industry's behaviour to enable key policy makers to review existing policies and determine appropriate policies for future implementation.

References

[1] ILO (2001) *The Construction Industry in the Twenty-First Century: Its Image, Employment Prospects and Skill Requirements*, International Labour Office, Geneva.

[2] HM Government (1999) *A Better Quality of Life: A Strategy for Sustainable Development for the UK*, Cm 4345, The Stationery Office, London.

[3] HM Government (2005) *Securing the Future - UK Government sustainable development strategy*, Cm 6467, The Stationery Office, London.

[4] Runge, D. (1977) *Towards Understanding SD – A D-Memo*, System Dynamics Group, MIT

[5] Forrester, J. W. (1989) *The Beginning of System Dynamics – a Banquet Talk at the international meeting of the System Dynamics Society,* Stuttgart, Germany. D-Memo D 4165-2, MIT.

[6] Forrester, J. W. (1961) *Industrial Dynamics*. Cambridge MA: Productivity Press.

[7] Forrester, J. W. (1969) *Urban Dynamics*. Cambridge MA: Productivity Press.

[8] Forrester, J. W. (1973) *World Dynamics.* (2 ed.), Cambridge MA: Productivity Press.

[9] Meadows, D. H., D. L. Meadows, J. Randers, & W. W. Behrens III. (1972) The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind. New York: Universe Books.

Factors affecting successful stakeholder management in construction project management processes

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Construction projects, especially those located in the UK public sector, are effected best when consideration is given to the needs of project stakeholders and those needs are incorporated into the construction project management processes. Stakeholders are recognised within the project implementation plans developed by project managers for the delivery of large infrastructure projects funded jointly by the public and private sector. The thesis of this paper is that similar approaches are especially needed for smaller scale projects that are situated in the public or quasi public sector of the UK economy.

An initial conceptual model is determined that can be used to shape and collect qualitative data from the field. The case for a focused exploration of stakeholder management practices is made that are related to a number of case study projects drawn from NHS healthcare projects. It is posited that such a study would allow a robust framework to be developed that practitioners would use to aid their decision making.

Keywords Stakeholder management, success factors, construction project management

1. Introduction

The formula to ensure success in construction project delivery processes includes the identification and satisfaction of all success criteria. Such criteria need to be established following the involvement of client organisations and other project stakeholders. It therefore follows that construction project managers need to adopt effective strategies to manage project stakeholders as well as other project processes related to time, cost, quality, sustainability and safety in order to effect project success. The established theoretical approaches to project stakeholder management are examined and they are placed in the context of actual stakeholder management practice in the UK construction industry so as to identify factors that need to be given particular emphasis.

A review of literature related to stakeholder management processes, project success criteria and the PFI procurement processes related to NHS healthcare projects is undertaken. This analysis allowed a conceptual model to be developed that is able to guide the collection and analysis of data collected from the field.

2. Research background

Stakeholders can be defined as "individuals, or organisations, who are positively engaged in a project, or whose interests may be positively or negatively affected as a result of project execution or

successful project completion", (PMI, 1996). Such broad definitions indicate that construction projects can be affected by or can affect a range of direct and indirect project participants and as a result project managers must devise strategies that will ensure that their projects are delivered as successfully as possible. Winch (2002) sets out the key elements of such a strategy as being, stakeholder classification, stakeholder identification, stakeholder mapping and analysis. Mitchell *et al* (1997) suggested that project stakeholders could be classified as primary or secondary, as owners or non-owners, as owners of capital or less tangible assets, as actors or those acted upon.

Whereas Hobbs and Dawood (2000) offered a classification that used direct and indirect as the key terms for differing types of project participants. Similarly Winch (2002) used terms such as internal and external for classifying differing types of stakeholders. The literature is far from agreed on just what should be the optimum classification and identification system for construction project stakeholders and so an exploratory study with project stakeholders engaged with a PFI Healthcare project would provide an opportunity to explore the classification and identification system that is grounded in current practice.

Newcombe (2003), and Winch (2002) both suggest that stakeholder mapping tools are useful for the subsequent management of project stakeholders. They assert that a matrix of power and interest and /or power/predictability provides a basis upon which the previously identified and classified stakeholders in any project scenario could be mapped, analysed and subsequently managed. The suggested matrix consists of two dimensions, namely, (i) the power of the stakeholders to influence the project and (ii) the level of interest that the stakeholder has in that project situation.

3. Conceptual model development

Mitchelle *et al* (1997) assert that stakeholder management approaches can be either 'firm centred' or 'system centred'. This approach sees stakeholder management as a means of value creation and hence as a process by which an organisation could generate improved financial and other non-tangible assets which can then be used for competitive advantage. Cleland (1994) addressed the issue of stakeholder management and developed a management process that had at its core the key management aspects of planning, organising, motivating, directing, and controlling the resources to cope with external project stakeholders competing demands. Actual practice on the ground needs to be explored to develop robust approaches that practitioners could use to enhance the potential of project stakeholders.

4. Conclusions

Conceptual models of stakeholder management had been considered in work reported by Freeman (1994). This work offered a framework based on empirical models of stakeholder management practice. This initial framework was refined by the work of Berman *et al* (1999) who made the case for a conceptual model of stakeholder management to be developed. This is a major difference between the conceptual models advanced in business focused industries which place emphasis on project related profits alone as it is posited that such an approach in a construction context would jeopardise the achievement of optimal project success levels. It is further asserted that this approach is particularly necessary for construction related projects drawn from the public purse, such as projects related to healthcare facilities provided via a PPP procurement approach.

The conceptual model is based on the need for project managers to delver projects for Healthcare facilities in the UK. The model reflects the differing phases of a project's lifecycle and shows the need to continual inter-action in terms of reference to the needs of project stakeholders and their impact on the already established project success criteria across the differing phases of the project delivery lifecycle. The literature reviewed above indicated that in terms of stakeholder management there were three main elements that needed to be taken into account, namely, the identification, classification and mapping of all stakeholders especially those classified as belonging to the 'key player' category. The more significant parts of the conceptual model need to be confirmed and further refined following the administration of an effective research design.

5. References

Freeman R E (1984) *Strategic Management: A stakeholder approach*, Boston, Pitman

Henriques I and Sadorsky P (1999) The relationship between environmental commitment and managerial perceptions of stakeholder importance, *The Academy of Management Journal* 22:125-139

Hobbs, B and Dawood N (2000) Harnessing the power of virtual reality – the potential for VR as a virtual integrated environment for project development in construction, *Proceedings of Berkley-Stamford CE&M workshop*

Mitchelle RK Agle BR and Wood DJ (1997) Toward a theory of stakeholder identification and principle of who and what really counts, *Academy of Management Journal,* 22 (4) 853-886

Newcombe R (2003) From client to project stakeholders: a stakeholder mapping approach, *Construction Management and Economics*, 21 841-848

Project Management Institute (1996) *A guide to PMBOK*: USA Autographics Systems

Winch GM (2002) *Managing construction projects*, Blackwell Science

Project process from the client's point of view

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Today, there are projects under construction in Japan wherein parties that are employed in a support role by the clients which are neither architects nor contractors. In a number of researches done on clients, including this study, we try to establish a new construction production system that is adapted to the changing attitudes of clients. In this study, we have organized the process of construction production from the clients' point of view, and compared the process with the traditional "briefing-design-build" process which is regarded as general common practice. We analyze case examples using a method of mathematical sociology to organize the process of construction production from the clients' point of view. As a result of this analysis, we have shown that the division points of the process from the clients' point of view are different from those of the perspective usually adopted.

Keywords: client, consultant, construction project process, project management

1. Introduction

Today, more and more clients employ parties in a support role in construction project coordination in Japan. In the past, architects or contractors have performed the tasks, in addition to basic services. Today, however, most of these tasks are now performed by the other parties. This is because of the increase in complaints arising from clients about usual construction project coordination, with the emphasis being on financial efficiency and their cut in personnel and aggressive outsourcing. However, there are many kinds of consulting services, and there is no scope or set of parameters for these services. In order to systemize these consulting services and deal with the clients' complaints effectively, the process of construction production needs to be reconsidered from the clients' point of view.

In previous studies, the clients' consciousness of the tasks performed by contractors are identified [1], the relationship between the change of the clients' consciousness and an increase in construction management is described [2], the original components of project management and construction management are explained [3], the components of the briefing and each role of a particular party within the process of the briefing are described [4]. Thus, the various issues involved in the tasks of the clients are argued. However, study on the structure of the clients' tasks analyzed in detail through focusing on the clients' tasks and processes involved in such tasks has not been done.

This study focuses on the following aspects:

- The tasks of the clients are organized, and the method for analyzing them is suggested.
- Case examples are analyzed and the process of construction production from the clients' point of view is adopted.
- In the process of construction production from the clients' perspective, the workflow of the clients and the division points of the process are identified.
- The division points of the process from the clients' point of view are compared with the division points traditionally observed.

2. Identification and structuring of the clients' view

The client's tasks are identified in reference to the documents pertaining to project management [5]. Any tasks that are performed for a specific construction projects are added then compared with the 1206th ministerial announcement [6] and confirmed by the practitioner, finally, the 133 tasks are identified. The tasks are structured by ISM (Interpretive Structural Modeling) developed by Warfield [7]. Using this method, the processes of the tasks are identified.

3. The division points in each building use

In this study, the projects are categorized into "business use" and "personal use" based on the buildings function. In the projects designed for personal use, the tasks relating to the decisions made, in terms of the direction of the projects, are identified as the division points. In the projects designed for business use, early securement of feasibility of the business and the client's authorization depending on the degree, are needed.

4. The division points in each character of the clients

Projects are categorized into "Self-PM" and "PM-outsourcing" based on the characteristics of the clients' selected preferences. In projects which involve "PM-outsourcing", there are fewer tasks for the clients to perform, but these tasks indicate the phases which make it difficult to complete the purpose of a project without the clients, or they have to take responsibility pertaining to decision-making.

5. The process from the clients' point of view

5.1 Phase (1): Planning of the business scheme

In this phase, clients confirm the purpose and concept of the business, and plan a general business scheme. Through this phase, the clients focus on their consensus building of the project in-house. On the one hand, the contractors focus on arranging given conditions for basic designing.

5.2 Phase (2): Confirmation of the business scheme

In this phase, the clients adjust accordingly to realize the business scheme, and confirm the business plan with the other participants. They focus on their decision to implement the project in-house. Conversely, the contractors focus on confirming given conditions for basic designing.

5.3 Phase (3): Documentation of the business scheme

In this phase, the confirmed business scheme is organized with the conditions of design taken from a technical perspective, and is presented to the architects. The division points of this phase change depending on the focus of their confirmation, reconsiderations, or decisions. On the one hand, the contractors focus their attention on the creation of drawings and specifications.

5.4 Phase (4): Convert to cost information of the business scheme

In this phase, the documented business scheme is converted to cost information such as construction cost, business cost, and business revenue. It is important for the clients that the specifications detailed and the quality of the drawings and specifications stay within the budget parameters, including operation and maintenance costs. On the one hand, the contactors are primarily responsible for the preparation before starting construction after the execution drawings and specifications are created.

6. Conclusions

In this study, the clients' tasks are organized and identified as a total of 133 tasks, and the method of structuring them by ISM is suggested. Next, by this method, the division points of the process of construction production from the clients' perspective are identified. Finally, the phases caused by the division points are compared with those traditionally observed, and the process of construction production is reconsidered from the clients' point of view.

The future goals of this study are as follows:

- The clients' tasks have to be organized in the new business scheme, including the securitization of the business regarding development types or PFI business.
- The processes of construction stage and maintenance stage have to be analyzed.
- Reconsideration of the tasks done by contractors, and organization of the services utilized in support of the clients are needed.

References

[1] Takashi Miisho et al. (1999) Client satisfaction on building construction project: Journal of Archit.Plann.Environ.Engng., No.521, pp.237.

[2] Naruo Kanoh et al. (2001) Survey on the attitudes and opinions of clients for building construction projects -Transition in clients' views in the 1990s-: Proceedings of 17th Symposium on building construction and management of projects, pp97-102.

[3] Tadashi Eguchi et al. (1995) Project management approach by pure-consultants or by risk taking contractors? –Separation and connection in their concepts and practices: Proceedings of 11th Symposium on building construction and management of projects, pp.83-90.

[4] Hideo Iwashita et al. (1982) New architectural system: Shokokusya Publishing, Japan.

[5] The Japan Institute of Architects (2002) JIA-PM Guideline.

[6] Former Ministry of Construction (1979) the 1206th ministerial announcement

[7] Hisashi Ishitani et al. (1992) Social system engineering: Asakura Publishing, Japan.

A risk decision model for real estate development

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In this paper we present a decision model to address risks in real estate development in a simple and efficient manner. The decision model can be seen as a first step in the decision-making process to assess risks and to structure the use of more sophisticated, quantitative risk analysis techniques. The novelty of the decision model is based on the use of generic knowledge of the real estate development process that is translated into a set of decision moments, decision items, decision rules, decision criteria, and decision hierarchy. These basic ingredients of the model can be made specific for each organization based on their specific risk attitude, risk capacity and risk strategies. A case-based example illustrates the working of the decision model and its implications and limitations.

Keywords: risk management, decision model, real estate development, case study.

In the field of real estate development the need for risk management is widely acknowledged, but the application of existing risk analysis techniques is limited. The arguments given against the application of risk management are, inter alia, a lack of expertise, inadequate knowledge of risk analysis techniques, lack of time and a lack of understanding of potential benefits [1]. This paper presents a risk decision model from a constructive approach that elevates some of the limitations of the traditional, engineering techniques.

1. Risk management

Two basic assumptions with regard to risk management are made. In the first place, risk is considered to be a subjectively measurable concept and therefore a 'constructively simple' approach to estimating is suggested. Such an approach implies that decision-making is an iterative process, 'starting out with a perspective that is transparent and simple, but which goes into more detail in later passes to the extent that this is useful' [2]. Moreover, risk is considered to be a social construct, which implies that risk is a consequence of a decision [3]. In other words, a risk is inseparable from a risk-taker or decision-maker and the magnitude of the perceived risk is related to the risk capacity of an organization and the risk attitude of a decision maker.

2. Real estate development

Regarding the real estate development process, the decisions that are to be made are to a large extent generic. The decision moments correspond with the gates between the phases in a development process. Phases divide the development process in sequentially following time periods during which functional processes are carried out simultaneously. A functional process is a group of activities aimed at accomplishing a certain necessary aspect of a real estate development, such as land acquisition, planning application, design and construction, marketing and sales, and financing. These processes are generally known from experience and the repetitive character of the development process. As the risks of a real estate development relate either to the autonomous activities or to the interdependency of the functional processes, the risks are also to a large extent generic. At the gates it is important to evaluate each of the activities as well as to tune the interdependent processes in order to control the risks.

3. Risk decision model

Following the idea that a risk is a consequence of a decision and the generality of the decision problems and the risks in real estate development, it is possible to determine the level of risk that is acceptable in advance of a decision. This so-called preliminary risk response can be defined as decision criteria in terms of preliminary results. This line of thinking is opposite to the traditional approach in which first a risk analysis is made and subsequently is decided on the risk response. The risk decision model is based on the idea that the generic tacit knowledge on real estate development can be made explicit in a framework of decision moments, decision items or risks, and decision criteria. The model is completed with a set of decision rules, similar to a traffic light procedure, and a decision hierarchy, which should guide the decision-maker in the decision-making process. The functions of the ingredients are:

(a) Decision moments: a decision moment, or gate, is defined as a 'project review point' [4]. The decision moments are an essential part of the decision model as the decision items and the decision criteria depend on the decision moment. The amount of decision moments depends on the risk strategy of an organization. A large number of decision moments means that a project is frequently evaluated implying a high level of control.

(b) Decision items: a decision item is a key risk in the development process. A key risk is a risk of which is known by experience that it might have either a high probability or major consequences. A decision maker must reckon with these risks and determine whether in a particular project it is a high risk and to what extent it can be controlled. To determine the acceptability of a risk, the decision criteria and decision rules are used. In the metaphor of the traffic light process a decision item or risk is a traffic light. However, at a certain decision moment multiple traffic lights are encountered and have to be weighed simultaneously using the decision rules. The amount of decision items depends on the risk strategy of the organization.

(c) Decision criteria: for each decision item decision criteria are defined in terms of preliminary results with regard to the decision moment. For each decision item three criteria are determined: a green light, a yellow light and a red light.

(d) Decision rules: the decision rules for the decision model can be divided in two. Decision rules for a single decision item and decision rules for the evaluation of all decision items together. The rules for a single decision item are: if a project meets the green light criteria a risk is acceptable, if it meets the yellow light criteria a risk needs further analysis, and if a project only meets the red light criteria a risk needs to be avoided. The rules for the overall evaluation are: one single red item implies a ‘no go’, only green items imply an indisputable ‘go’, and no single red and one or more yellow items means that further analysis is necessary and/or the decision problem is to be submitted to a higher level in the decision hierarchy.

(e) Decision hierarchy: for each decision level in an organization decision criteria must be determined with regard to its decision authority. The number and amount of specification of decision criteria decreases according to the increase in decision authority. The board of directors has more margin to decide on taking risks than at the project management level. This means that when a project manager meets a red light, at this decision level a ‘no go’ for the project is given and subsequently that the decision problem must be submitted to the next decision level. Because of the extra margin in decision criteria it is possible that at a higher decision level the problem meets a yellow light and based on supplementary risk analyses the decision can be turned into a ‘go’.

4. Conclusions

The presented risk decision model is still in the early stages of development. However, the model is based on an extensive interview survey on the Dutch real estate development sector and is applied on six cases concerning the development of housing estates and a retail project by two development companies. These cases show promising results as the model proves to be suitable to describe several decision problems. Especially with regard to each separate decision item the decision rules are clear and may lead to a prescribed decision, like ‘go’ or ‘no go’. However, as multiple decision items need to be weighed simultaneously, the decision rules do not prescribe a final decision. At this point the decision criteria in the model need to be treated as rules of thumb. The integral consideration of the decision items is left to the cognitive abilities and entrepreneurial characteristics of the decision-maker. At this moment not only the risks need to be taken into consideration, but the opportunities as well. To support this elaborate consideration further risk analyses might be useful of which we consider a scenario analysis as the most suitable technique. Thus, the model needs to be seen as a first step in the decision-making process and be complemented by addressing the other steps in this process. Finally the definitive model needs to be tested in several other organizational contexts and by experts in the field of real estate development to evaluate whether the model corresponds to their realm of thought.

References

[1] Lyons T. and Skitmore M. (2004) Project risk management in the Queensland engineering construction industry: a survey. *International Journal of Project Management*, 22(1), 51-61.

[2] Chapman C.B., Ward S.C. and Harwood I. (2006) Minimising the effects of dysfunctional corporate culture in estimation and evaluation processes: A constructively simple approach. *International Journal of Project Management*, 24(2), 106-115.

[3] Luhmann N. (1993) *Risk: a sociological theory*. Walter de Gruyter, Berlin.

[4] Schmidt, J.B. and Calantone, R.J. (2002) Escalation of commitment during new product development. *Journal of the academy of marketing science*, 30(2), 103-118.

New production and service roles of the building firms in Italy: problems and perspectives

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The new production and service roles, especially detectable in significant tranches *of the Italian building firms, and typical of late-industrial scenarios, offer interesting evolutionary potentialities. They also poses, however, still open issues. This contribution discusses such questions, updating and contextualizing into the Italian case the results of previous studies, researches, etc.*

Keywords: Building firms, production, services.

1. New production and service roles of the building firms in Italy

The strategic role of the *service* and *product service* supplies is largely demonstrated in the diversified contexts of mature industrial realities. These supplies, denoting markets where additional *complexities* due to innovative products converge and requiring managerial contributions in the typical phenomenology of the contemporary economies, etc., are decisive for the qualification of the performances provided [1], and pose interesting development perspectives. They also put in evidence, however, recurring emphases that often risk marginalizing the *production factors*: it can be easily recognised that such risks may result in non positive effects for the markets concerned with *basic* supplies of production type (construction, fittings, etc.), and for the same companies therein involved (defeats of consolidated backgrounds, etc.).

Even in the field of constructions, the higher *complexity* of the innovative products (where it is possible to recognise performance increments and/or diversifications, declared tendencies towards environmental impact minimisations, etc.) increasingly require suitable *instruction for use*, maintenance procedures, etc. In more general terms, the present needs for strictly *managerial* contributions in the deployment of the building processes, while pursuing objectives of efficiency and efficacy of the activities and expected results (artefacts, infrastructures, etc.), entail the requirement for new roles and *service supplies* whom often concur, among the other operators, companies already committed in building performances. In Italy, especially in the most *advances* realities of the building sector, it can be more and more recognised the integrated supply of production and management of the maintenance cycles, monitoring, etc., or even contributions in the *project-financing* frameworks, *global service* activities, social-cultural initiatives such as *district laboratories*, etc.; mainly associable to the models of the Italian *impresa-rete* [2], tendencies towards *production and service* supplies therefore delineate *new* roles and entrepreneurial functions in this country: they develop indeed the *traditional* performances of *direction of the production activities* by the *general firms*, evolving into policies of supply diversification that can be carried out in this way, precisely, also through different *service* contributions.

Therefore, the *new* roles of *production and services* of the building firm offer the possibility of relevant evolutionary developments. They also pose, however, still unsolved issues. The results of previous studies, researches, etc., concerning the sector of constructions in Italy and in some European countries ([2], etc.), put in evidence among other things issues connected to a certain extent to the present discussion; analogously according to what previously mentioned, they assume and modernise the most significant implications for the Italian context.

2. Problems and perspectives

Already since the second half of the Eighties, the activities of the building companies in Italy appear as something less and less compressible inside "…the sole construction yard... The realization process of the buildings is expanding until requesting the company promotional and design capacities, financial and managerial services, warranties of a correct execution of the work... Takes... form a possible new strategy of the supply... The firm has… to face new market spaces, being able with its own ability to plan to organise and promote the demand... We are therefore facing a *technological jump* that can not be dealt with in the *construction yard*, but must increasingly push the entrepreneurs in the analysis of the external world for the implications that its behaviour do have for the firm... It is established... a model of *open firm* where the marketing assumes the role of *integrating* the new company functions to satisfy and stimulate in the projects the expressed and unexpressed needs of the client-market" (Tangerini, cited in [2]). Interesting perspectives emerge about the possible development of the capacity of *anticipating and satisfying future needs*, for those companies that operate with supply diversifications (products, services) and by means of suitable management (in their own productive and functional organization, in a renewed *culture of marketing*, etc.) able to identify and support *expressed and unexpressed needs of the client-market*; valid preambles are posed indeed for evolutions of significant *tranches* of the building firms in Italy: from operators that used to be *receptors* of market inputs (according to meanings that are traditionally *adaptative* of the *company flexibility*), to *subjects propulsive of modification and development*. Coherent *innovation strategies* moreover, *aimed at* identifying and satisfying new and *actual* needs (both *explicit* and *implicit*), cover analogue evolution possibilities for the markets [2].

At the same time, however, still open issues arise. Against a management specifically oriented to service supplies, that covers the present orientations of the most *advances* Italian building companies, there is no correspondence with significant mainly *technical-executive* optimisations, and notwithstanding even in this country (where traditional *savoir faire* anyway persist) it can be detected a certain spreding of innovative products and technologies: *composite*, *structural glass*, etc. It is known, however, that the same *evolutionary* models of the *impresa-rete* rather include strategies of production outsourcing towards the subcontractors, reserving to the *general firm* the maximization of management roles, and precisely, of *services*: therefore, the tendential rarefaction of executive performances in the general firms results, for the companies themselves, in "...weakening of their own models of productive organization …" [2], and therefore in the risk of deficit in the activities of production management and *product services*, defeating of technical-construction backgrounds (against service supplies that are tendentially *substituting* these latter ones), etc. In more general terms, moreover, superabundance of *service performances* (when not appreciably integrated with *production supplies* and/or tendentially marginalizing these latter ones), and involving also already active companies especially with *production* contributions in the Italian building market and its important *tranches* (requalification, restoration, etc.), though not rarely with commixtures of sub-contractor roles, brings the risk of impoverishment of technical-executive competences, and reduced competitiveness, *potential or not*, for such operators (small size structures, artisan firms, etc.).

Although *decisive* for the qualification of supplies, and the innovation on the markets, the role of *services* can not be therefore defined aside from *production* optimisations, and can not be considered *substitutive* for sure. The *new* roles of the Italian building firms therefore delineate real advances (in terms of *new* intervention opportunities, qualification of the supplies, competitiveness, etc.), and effective innovations in the markets, provided service performances are guaranteed that do not marginalize the productive contributions, and that are *compatible* with *plausible* development scenarios and dynamics in the field (demand, requirement modifications, etc.): conditions, these latter ones, *formally* shared but not rarely disregarded, on the contrary, in the current practices. We therefore confirm their relevance, as *general inspiration lines* for processes of *virtuous tertiarization* of the building firm (*urban maintenance firms*, development of *product services* such as monitoring, etc.); these can be charged however the number of different *correction measues* (tendential maximisation of the integration *product-service*, limitation to the superabundance of the second ones, etc.), in relation among others to those *critical nodes* that are briefly recalled.

Especially the *compatibility* of the production and service supplies with the *plausible* scenarios and evolutions of the Italian market, that therefore may guarantee processes of *actual* qualification of the performances provided, requires a *aware governance* of the changes in course: removing, or at least reducing unacceptable modifications in the development of the demand (*induced needs*, etc.), that are often *complementary* to the *immediate*, although ephemeral, objectives of market success of the *new offers*. It emerges the need for a technical policy that is *renewed in its contents*, and ensure a *virtuous development* of the service supplies within an evolutionary function for the field of construction and the operators involved. Decisive, although in opposite trend with the current opinion, is the *public* role of *governance of this sector* [3].

References

[1] du Tertre C. (1999) Intangible Interpersonal Services Adjustment and Reduction of Working Hours: Toward New Political Economy Tools. The French Case. *Service Industries Journal*, 19 (1).

[2] Multiauthor volume (2000) *Organizzazione e flessibilità dell'impresa edile*. Alinea, Florence.

[3] Giallocosta G. (2002) I nuovi ruoli dell'impresa edile fra produzione e servizi. *Quasco*, 58.

An international comparative study considering site production for sustainable construction

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This informative paper considers the sustainability of the construction production process at site level sequence to a recent comparative study carried out between the U.K. and Swedish construction sectors of industry. Works carried out on modern house construction sites should be executed to suit end-user and Client requirements as well as regulatory measures and the sustainable development agenda. To avoid non conformance at site production level, instructions communicated via the industry supply chain must be clear, unequivocal and sent without delay. However, in reality this is not the case where a percentage of rework as well as delays on site occur during the construction phase of the project. It is perceived that reasons for such non conformance may include poor communications, individual's attitudes and a lack of resources. The paper considers these and makes informed recommendations for more efficient processes whilst improving the quality of the end product, providing better sustainable values for the construction stakeholders. In order to capture this information a series of site interviews took place based upon a semi structured questionnaire. This allowed understanding of the dynamic house construction project describing individual's attitudes and vision providing some very interesting discoveries.

Key Words: Communication, efficiency, production, requirements, sustainability

1. Introduction

This paper is the follow up spawned from a speculative paper delivered to the international academic community at the Salford Centre for Research & Innovation (SCRI) Symposium [1]. The original piece of work considered works executed at site level for residential housing and the inefficiencies at site production level leading to non conformance that occurred during the construction phase of the project. It was found that such non conformance did not reflect the clients brief or contract specification. It was understood that such causes included not only the fragmentation of industrial stakeholders within the sector but the disorganization and misunderstanding of human resources within the internal construction organization. This informative study focused on understanding the coactions between such stakeholder members that could lead to the inefficient execution of works at site level concentrating on site managers and trade and groundwork operatives involved in the frontline of the construction project.

The paper reports on the behaviour, trust, loyalty, experience and reliability of communication between site operatives and site supervisors at site level and proposes changes in strategy and process for improving sustainability values on the U.K. and Swedish construction sites.

2. Methodology

The studies main focus was on the relationship between the site manager and his/her operatives during the construction phase of the construction project. In order to achieve this, researchers in both the UK and Sweden carried out interviews with site personnel. A semi-structured interview format was used to ensure consistency in the topics discussed [2]. Once access was granted both the construction managers and operatives were very helpful. The manager would ask trade and other site operatives who were on a break or waiting to execute works if they were prepared to take part in an international research study. The initial interest allowed for researchers to take advantage of the site operatives genuine interest.

In the UK, thirteen site interviews took place with 4 interviews in Sweden. Each interview lasted between 30 minutes to 45 minutes. Through these, information was gathered and knowledge captured in both the U.K. and Sweden.

Once established it was possible to carry out two comparative analysis. The first developed to understand the difference in accomplishing sustainable values at site production level due to the implications of organisational size. Here consideration as to whether an sme would be able to control site production better then large enterprises and visa versa was established. The latter was an international comparative analysis in construction practice aligning similarities and establishing differences that have an effect upon production at site level. In addition due to the fuzzyness of the questions posed during the interviews, discussions occurred that brought about understanding of how different construction stakeholders considered members of the supply chain. For instance trade operatives have a general view on the competence of those members of the supply chain dealing with the front end where the concept of the building project is conceived and the design of it achieved. Furthermore it was found in both the U.K. and Sweden delays occurred due to unclear and impractical specification as outlined in the contract drawings established at this high level. Though in contradiction at site level and generic in both countries operatives have hidden codes of practice where faults occur that do not cause major disruption to the contract they are not reported to the higher management. This is perfectly acceptable at site level but frowned upon at Managerial level.

The questions were divided into three categories; the first dealt with personal details including size of enterprise, job description and areas of expertise. The second dealt with issues relating to delays on site such as those mentioned above. The third section was developed to capture information relevant to the site operative's knowledge of Sustainable Development and sustainable values that could be gained at site level. There were other aspects that arose during the interviews which are outlined below.

3. Delays on site

It was found that there were several delays on site, mostly generic in both the U.K. and Sweden. First and foremost the concern centred on the various stakeholders working on site and whether they delayed each other during the construction phase of the construction process. In the U.K. an obvious delay was the inclement weather which as a bricklayer their task is impossible to achieve on a housing project. This differs on industrial buildings where the frame consists of steelwork; in this instance once the corrugated roof is in place then the wall construction can be achieved under shelter.

It was established that on site one of the major delays was waiting for materials. This in the U.K. can be more damaging when brickwork is delayed because the bricklayers tend to be subcontractors rather then direct labour. In Sweden when the bricklayers are delayed the site manager can usually find them something else to do so the economic loss is reduced. Generally however this process is inefficient and needs to be rethought in order to be sustainable.

Another popular fault is on the technical side where the site manager may recognise that some detail outlined in the contract drawings will not work in practice. For the architect to be informed of such a fault is a laborious process and by the time the altered drawings to make better the technical aspect reach site several weeks may have elapsed. It was found in one case that where the manager believed the drawing to be wrong he made alteration himself and gave the go ahead for construction. His superiors trusted his judgement and gave him such authority. This is a good example of integration of the supply for the good of the project. This did however usually lead to delay as the contract drawings were altered to accomplish solution to the new found problem. This was the main cause for disruption of Swedish projects including the poor communication of drawings through the supply chain to site. This causes the 'ripple effect' leading to social frustration and economic loss.

Other work related delays unless considered to be significant were not reported to higher management but dealt with secretly. It was found however that the micro company did not suffer from some of the delays and had simple strategy to make good arising problems. The small company had only themselves to answer to and were more involved because it was their money that was being used to construct. Therefore if delays or technical problems occurred they would inevitably pay the bill.

4. Relevant issues

The paper considers the site operatives knowledge of the Sustainable Development agenda and sustainable practices on site. It also looks at waste on site and mechanisms for recycling and waste reduction. Again the micro company appeared to waste nothing recycling bits of wire and plasterboard for other tasks. Here a section considers the sustainability of products.

5. Conclusion

During the field research carried out there were split interpretations of whether a site production check list was necessary and would improve the standard of the construction end product. Though some perceive that the knowledge and information gained through the use of such a checklist could improve sustainability values on site as operatives consider the Sustainable Development agenda and the Triple Bottom Line in their daily tasks. In addition it was established that there is a need for better social interaction and integration of the supply chain to produce more efficient sustainable end products.

Value-at-risk concept in a holistic risk model

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All enterprises in the construction sector, particularly construction companies, face very high economical risks. This paper presents the risk load dimensions as the first part of the holistic, probabilistic enterprise risk management model to control the risk load, the risk coverage resources and the risk resistance of project oriented companies. The holistic company risk model (RMP-M) was created at the ETH Zurich, enacted by and in collaboration with the Swiss Association of General Contractors.

Keywords: Holistic risk model, risk load, value-at-risk

1. Introduction

The holistic, probabilistic overall enterprise process model (RMP-M) consists of three dimensions. In these model dimensions, the Cash flow Model / Asset risk model and the risk load resistance theorem will create the core of the RMP-M with the following structure (Fig. 1):

- Risk load dimension – bottom-up approach
- Risk resistance capacity dimension – top-down approach
- Risk load-resistance theorem – integrative approach

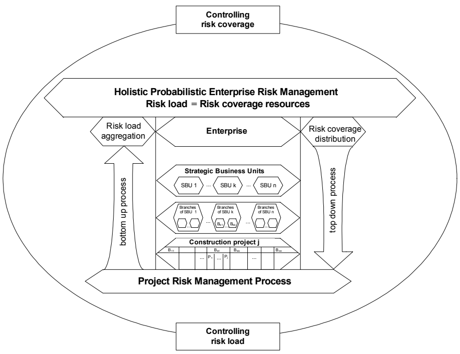

Fig. 1: Structure of the holistic, probabilistic Risk Management Process Model (RMP-M) for project-oriented enterprises

2. Risk load dimensions

The risk load dimensions differentiate risk loads at various levels of a company and are based on the following three concepts:

- Risk aggregation theorem
- Cash flow risk model (CRM) and Asset risk model (ARM)
- Risk load scenario model and risk load theorem

The levels of a company as outlined in Fig. 1 comprise e.g. (from bottom to top) the project level, the branch office level, the level of strategic business units (SBUs) and the level of the company overall. With the help of the risk aggregation concept, the risk costs of all projects of a branch office, of a strategic business unit and the total project risk of the company can be determined.

The cash flow and asset superposition concept is used to calculate the distribution functions of the operative probabilistic cash flows / assets at the various corporate levels. The resulting risk load is determined using the value-at-risk approach for various load levels (load scenarios).

After signing the construction contract every company has accepted particular risks (Fig. 2).

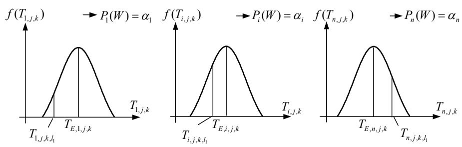

Fig. 2: Probability density distribution functions of impact cost of risk in project j

Risk aggregation theorem

With reference to the central limit theorem of the stochastics and the Monte Carlo Simulation [1] the probability density function and cumulative distribution function of the risk cost in project j can be determined by the value of the expected risk cost $R_{E,project\ j,k}$ and the variance $\sigma^2_{project\ j,k}$ of risk cost. The probability density function in this case is quasi normally distributed independent of the density function of each risk if the number of risk is high enough (e.g. ≤ 10).

According to the central limit theorem of the stochastics the aggregated total risk cost and the variance of risk cost of the enterprise level can, according to [1], be expressed as follows:

$$R_{E,total} = \sum_k \sum_j \sum_i \left(R_{E,i,j,k} \;\middle|\; R_{E,i,j,k} = \sum_{l_1} \left({}^{l_1}T_{i,j,k}\,(p_{i,j,k,l_1}) * p_{i,j,k,l_1} \right) * P_{i,j,k}(W) \right)$$

$$\sigma^2_{total} = \sum_k \sum_j \sum_i \left(\sigma^2_{i,j,k} \;\middle|\; \sigma^2_{i,j,k} = \sum_{l_1} \left(\left({}^{l_1}T_{i,j,k}(p_{i,j,k,l_1}) - T_{E,i,j,k} \right)^2 * p_{i,j,k,l_1} \right) \right)$$

The related density and cumulative risk cost function:

$$f(R_{total}) = f\left(R_{E,total}\,;\sigma^2_{total}\right)$$

$$F\left(R_{project\,j,k}\right) = \int_{R^{\min}_{project\,j,k}}^{R^{\max}_{project\,j,k}} f\left(R_{project\,j,k}\right) dR$$

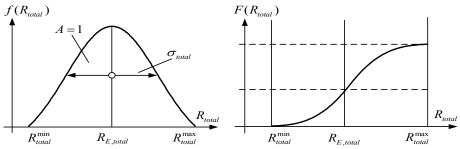

Fig. 3: Probability total risk cost density function and cumulative total risk cost distribution function of enterprise

CR- and AR-model

To design the CR- and AR-model for cash flow and profit impacted by risk, the reference point must be set at the start of the residual risk for the company. For this reason the CRM and ARM will be designed by transforming the cumulative total project risk distribution function into a cash flow risk function and a profit risk function by

1. creating a mirror image at the f(R_{total})-axis of the total risk cost density function of the enterprise
2. transforming the coordination zero point of the mirror imaged total risk cost density function at the magnitude of

$$R^{CF}_{Trans} = R_{\min} + R_{kalk,\,total} + CF_{kalk,\,total}$$

$$R^{G}_{Trans} = R_{\min} + R_{kalk,\,total} + G_{kalk,\,total}$$

The new functions will be called (Fig. 4)

- CRM : F($CF_{project\ total}$) – cash flow risk function
- ARM : F($G_{project\ total}$) – profit risk function

Risk load scenario model

To protect the enterprises from excessive dangerous economical risk, the following generic risk load limits will be created which must be below the economical risk resistance capacity of a company (Fig. 4):

- Normal risk load limit
  The "normal risk load limit" represents a statistical acceptance limit of $\alpha_N = 60$ % and will only be exceeded in (1-α) = 40 % of all cases.
- Stress risk load limit
  The "stress risk load limit" represents a statistical acceptance limit of $\alpha_S = 90$ % and will only be exceeded in (1-α) = 10 % of all cases.
- Crash risk load limit
  The "crash risk load limit" represents a statistical acceptance limit of $\alpha_C = 99$ % and will only be exceeded in (1-α) = 1 % of all cases.

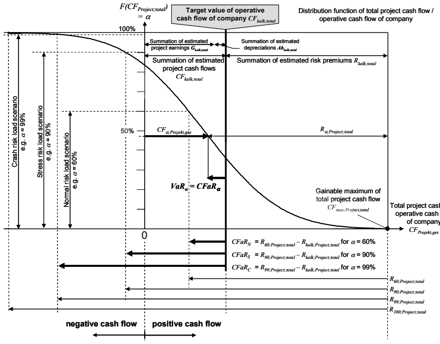

Fig. 4: Cash flow risk function of CRM - Risk load scenario model

Risk load theorem (Fig. 4)

According to Markowitz' portfolio theory, the risk load which endangers the anticipated cash flow or profit is called "value at risk".

Risk load at project j:

$$VaR_j = (R_{\alpha_j,project\,j} - R_{kalk,project\,j})$$

Risk load of SBU k:

$$VaR_k = \sum_j VaR_j = \sum_j (R_{\alpha_j,project\,j} - R_{kalk,project\,j})$$

1

Risk load of Enterprise:

$$VaR = \sum_k \sum_j VaR_{j,k} = \sum_k \sum_j (R_{\alpha_j,project\,j} - R_{kalk,project\,j})$$

C 5

3. Conclusion

The holistic probabilistic RMP-M offers a process instrument for companies to take risk consciously into account, and this in relation to the risk coverage, to maximize the profit. This paper represented the risk load dimension of the model. The risk resistance capacity dimension and risk-load-resistance theorem of the RMP-M will be presented by different papers.

References

[1] Girmscheid, G.; Busch, T. (2005): Ganzheitliches Risikomanagement in Generalunternehmungen. Institut für Bauplanung und Baubetrieb, ETH Zurich, 2005.

How much labor in construction?

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By using OECD input/output tables, this paper addresses the key issue of measuring construction related employment in developed countries. This matter is analysed according to a non standard index, such as vertically integrated sectors (VIS). VIS shows the labor incorporated to deliver, directly and indirectly, to the corresponding final demand of a given commodity and it can be a better measure of labour incorporated in the construction sector.

Keywords: Construction technologies, input/output, vertically integrated sectors, employement.

1. Introduction

In construction, labor usage is one of the key issues in most developing countries and this paper assesses the role of construction in enhancing this primary input growth. While it is widely acknowledged that construction can push an economy significantly in its first stages of development, its measurement criteria are still debated. This paper addresses another measurement index, the so-called vertically integrated sector or subsystem, that is, the linking of the input- output approach to labor utilization.

2. Data and stylized facts

In this paper the OECD input/output database developed by the Economics Analysis and Statistics Division of the OECD is used. The analysis is based on the '90s tables for the following countries: Australia, Canada, Denmark, France, Germany, Japan, United Kingdom and United States. All the figures refer to 1990 prices, with the exception of Australia, whose table concerns 1989. The analysis is supplemented by data on the sectoral labor usage provided by OECD.

3. A subsystem approach

Some authors [1] [2] define a subsystem or vertically integrated sector (VIS) as a gross output vector needed to supply a single commodity to final demand. Thus the Leontief model can be modified by considering a final demand diagonal matrix, say $\hat{\mathbf{y}}$, and derive the corresponding VIS matrix:

$$\mathbf{X} = \mathbf{B}\,\hat{\mathbf{y}} \tag{1}$$

The matrix is used to assess changes within the same economic system, but it is not very useful for inter-country comparisons. Hence, a different tool is needed, namely the so-called **S**-operator developed by Momigliano and Siniscalco [3].

This is obtained by dividing the matrix X row by row by the correspond-ing total output $\boldsymbol{x}_i$:

$$\mathbf{S} = \hat{\mathbf{x}}^{-1}\left(\mathbf{I}-\mathbf{A}\right)^{-1}\hat{\mathbf{y}} \tag{2}$$

The **S** operator cannot indicate which subsystem contributes mostly to construction output since it is impossible to figure out the column sum in matrix **S**, as the values are not homogenous. To overcome this problem, the matrix must be pre-multiplied by an appropriate diagonal matrix, whose positive entries can be either value added or labor coefficients. Let $\lambda = \left(\lambda^{R'}, \lambda^{C'}\right)'$ be the labor input vector, where the employment related to construction and that related to the rest of the economy are separated. Then:

$$\mathbf{L} = \hat{l}\mathbf{S} = \hat{\lambda}\,\mathbf{B}\,\hat{\mathbf{y}} = \begin{bmatrix} \hat{\lambda}^R & 0 \\ 0 & \hat{\lambda}^C \end{bmatrix} \begin{bmatrix} \mathbf{B}^{RR} & \mathbf{B}^{RC} \\ \mathbf{B}^{CR} & \mathbf{B}^{CC} \end{bmatrix} \begin{bmatrix} \hat{\mathbf{y}}^R & 0 \\ 0 & \hat{\mathbf{y}}^C \end{bmatrix} \tag{3}$$

In each column the **L** matrix shows the labor incorporated to deliver, directly and indirectly, the corresponding final demand of a given sector and, in each row, the contribution by each VIS to sectoral employment [2]. Thus, the rows show employment, which can be added up row-by-row to total labor in its respective sector. Table 3 shows the **L** matrix in Germany. All the figures are expressed in the same unit (i.e., thousands of workers).The sums displayed in the last column show the standard labor usage by each sector. This kind of data has often been used to assess the role of construction in an economy. The **L** matrix provides other interesting pieces of information. For example, it shows how much labor is required to fulfill final demand. The contribution of final demand of construction is quite relevant because it generates more than 60% of employment.

	Agric.	Mining	Manuf.	Electr.	Trade	Transp	Serv	Govn.	Constr	Total
Agric.	274	0	564	3	31	8	44	29	36	990
Mining	1	20	93	44	11	3	6	5	7	190
Manuf.	30	5	7666	36	210	81	140	228	444	8841
Electr.	2	1	94	104	21	5	12	7	8	254
Trade	13	2	948	15	3271	65	91	75	157	4636
Transp	8	1	375	12	90	957	52	55	71	1620
Serv.	8	2	642	22	222	57	1192	96	135	2375
Govn.	9	1	345	13	97	29	182	6498	61	7235
Constr.	2	2	105	11	25	12	79	12	1600	1847
Total	346	33	10831	261	3978	1216	1797	7006	2519	27988

Table 3 – **L** matrix for Germany 1990 (in thousands).

As implied by the **S** operator too, the final demand of manufacturing and private services is important to induce labor usage in construction. As shown in Table 3, in Germany the final demand of construction has a large impact in terms of generated job positions. This final demand, by activating labor requirements in other sectors, creates 9% of the entire country's employment, while, instead, the construction sector itself accounts for only 6.6% of German employment.

Table 5 shows a comparison of the considered countries in the OECD data set. The final demand of construction generates from 8% (in Denmark) to 17.7% (in Japan) of total employment. The data of the table raises another important issue, that construction is mainly sustained by its own final demand, and this demand, in addition, creates further employment in other sectors. Manufacturing and trade benefit significantly from the final demand of construction.

	Aus	Can	Den	Fra	Ger	Jap	UK	Usa
Agric	2.7%	2.5%	3.1%	1.4%	1.4%	4.4%	0.8%	1.8%
Mining	0.7%	0.7%	0.1%	1.5%	0.3%	0.2%	0.2%	0.5%
Manuf.	16.1%	13.4%	13.5%	9.6%	17.6%	19.4%	13.0%	16.2%
Electr.	0.7%	0.5%	0.2%	0.3%	0.3%	0.3%	0.9%	0.4%
Trade	10.1%	10.7%	5.9%	5.6%	6.2%	11.6%	6.2%	11.4%
Transp.	4.3%	2.5%	4.3%	4.9%	2.8%	4.3%	2.5%	3.1%
Serv.	5.0%	9.0%	9.4%	10.2%	5.4%	5.0%	9.5%	5.8%
Govn.	3.0%	11.6%	4.4%	2.1%	2.4%	4.9%	1.8%	2.6%
Constr	57.3%	49.1%	59.3%	64.3%	63.5%	49.9%	65.0%	58.2%
Share	13.0%	11.3%	8.1%	10.9%	9.0%	17.7%	11.3%	8.7%

Table 5 – Construction employment share in **L** matrices for selected countries

4. Conclusion

These notes have shown how to complement labor market data with the standard Input Output framework. The use of the Labour matrix shows how much employment is due to any entry in the final demand vector. This approach allows us to deduce how many job positions are created by construction final demand. The study also shows that in several countries construction generates further opportunities by fostering labor demand mainly in manufacturing and private services. Finally the authors argue that standard analyses, focusing on labor usage only, can be misleading, as the labor created by the final demand of construction is larger than that engaged in the sector itself.

References

[1] Sraffa, P. (1960), "*Production of commodities by means of commodities*", Cambridge University Press, Cambridge.

[2] Pasinetti, L.L. (1973), "The notion of vertically integration in economic analysis", *Metroeconomica*, **25**, 1-29.

[3] Momigliano, F. and Siniscalco, D., (1982), "The growth of service employment: a reappraisal", *BNL Quarterly Review*, 142, 26

Effects of future city development – Loss of efficiency

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Europe will be characterized by regions of growth and regions of shrinkage (economically and by demography). Growth and shrinkage can be located closely next to each other not only on regional level but also within cities. There will be areas with demand for new housing next to areas with a high vacancy ratio in the existing housing stock. The result is, that land use increases while in the long run fewer and fewer people will occupy existing residential areas. Both trends are about to reduce the overall efficiency of the settlement structure, - efficiency in economic terms and efficiency related to resource consumption.
The presentation will focus on the housing segment in municipalities with population decline, their future development paths and possible environmental effects. The findings from three case study cities in East Germany (in which the entire housing stock was analyzed) will be presented [1].

Keywords: Urban Structural Type, thermal envelope, brown field, CO_2 emissions, infrastructure costs
.

1. Introduction

The investigation was carried out as in-depth case study of three East-German-Cities. Focus of the investigation is the residential building stock and the technical infrastructure relevant for the accessibility within the residential area. Main roads for transit or non residential purpose are excluded. The research was carried out, using the urban structural type (UST) approach. An UST is a built up area of physically homogeneous character along which the urban area can be differentiated and most physical aspects (material flow, land take, ecological indicators) can be described. The UST approach is used to model future developments. The scenario settings were discussed with experts and approved by the town planning departments. During research a simulation tool was set up to model the housing stock 2020 and analyze it ex ante. The research will be presented via a fictitious city of 250.000 inhabitants and an expected decrease in population of 15 % until 2020 because involved cities asked for anonymization.

2. Method and scenario-model

The Leibniz Institute of Ecological and Regional development (IOER) developed a simulation tool to model the housing stock and associated technical infrastructure until 2020 and analyze effects of possible development paths ex ante. The model allows to calculate building material, land take and surface of the residential building stock as well as the associated energy and emission characteristic values. This can be done for the status quo and for possible future developments. The calculation model uses excel [2].
The scenario settings are in general discussed with experts and agreed by representatives of town planning departments.

For the “fictitious” city housing demand, residential areas (UST), building types and age groups were investigated ex post from 1995 to 2001 and then projected for 2020. As starting position it had to be considered that 25 % of the dwellings were vacant (2001). Due to population loss of 15 % until 2020 the housing demand will inevitable decrease.

A trend and a regeneration scenario were defined in cooperation with the town planning experts in order to illustrate the change of stock. For new construction the trend scenario it is assumed that 20 % will be built on “brown fields”, 30 % on empty plots and 50 % on new land (“green field"). The demolition activity amounts to approx. 1 % of the residential building stock 2001 per year. Till 2020 the vacancies will be reduced by 5 % to a level of then 20 %.

In the regeneration scenario the decrease in vacancies is clearly stronger. It will sink until 2020 by around 12 % to then 13 %. The demolition rate amounts to 1.3 % per year of the residential building stock in 2001. The assumption for new buildings were defined with 50 % use of brown field and 30 % urban “infill”.

3. Results: demolition waste

The quantity of demolition waste depends on the “desired” demolition ratio. The quantities of demolition were calculated for different building types within urban structural types (specific area, material and energy values). In the result the quantity and the kind of the demolition waste can be projected. In the regeneration scenario 980 tons of demolition waste per day must transported out of the city. In the trend scenario it will be 700 tons per day (fig. 1).

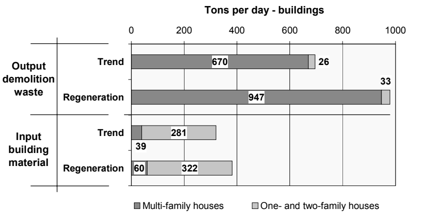

Figure 1. Material in- and output flow (tons per day) average over 20 years

In comparison the material consumption for new building is far lower. In both scenarios the material flow out of the city is 3 times bigger than the material inflow. The stock is not anymore growing by accumulating materials but demolition activities will make the city a net material "supplier", e.g. for the production of recycling construction minerals.

4. Results: land use by new building

Beside producing waste materials (secondary resources) the demolition of buildings produces waste and also new "brown fields". In the case of the trend scenario about 20 hectares per year will be "set free". In the regeneration scenario there are even 30.6 hectares per year, because the demolition activity is higher. Despite population decline new building construction will continue on low level mostly for quality reasons. Where this new construction takes place (brown fields, empty plots, new land), is decisive for the development of the city surface and especially the infrastructure.

In the regeneration scenario there is more building activity on brown fields and therefore the new gross land area take is 5 % less. The reason is the higher building density inside the city as opposed to developments at the fringe. Looking at the issue of new land take there is a high reduction in comparison to the trend scenario of 65 % (fig. 3).

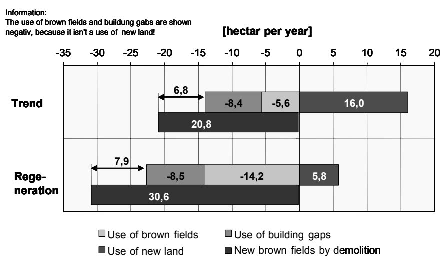

Figure 2. Urban land use (new construction and demolition) – comparison in different land use categories by scenarios (source: IOER)

In contrast in the regeneration scenario more brown fields are used for new building activities. Nevertheless there will be a permanent output of flow of brown field due to the demolition of building. This vacant land can only be used partially for new building. Both scenarios show therefore similar developments.

In both scenarios the land "output" by demolition is higher than the demand calculated for new building. In the trend scenario the difference amounts to 6.8 hectares per year, which means a permanent growth of brown field. In 2020 it will add up to 130 hectares of brown field. In the regeneration scenario this difference is even higher. The difference amounts to 7.9 hectares per year and will deliver until 2020 150 hectares for the fictitious East German city.

The $C0_2$ emissions per inhabitant won't decrease. The energy performance of building stock might be improved and savings of 11 % in heating demand are anticipated until 2020, but floor-space-consumption per household will increase by 8 % and there is a continuous move from apartment block to single family homes with high area/volume ratio. Therefore households will out weight the energy savings by consuming more floor space. Additionally, vacancies in the housing stock makes the thermal envelope of buildings grow in relation to the inhabited floor area. When the thermal envelope looks like "Swiss cheese" there will be an additional heating demand to "passivly" temper the vacant dwellings As a result the CO_2-emission per inhabitant won't decrease [3].

References

[1] Deilmann C. et al. (2005) Kommunales Stoffstrommodell Wohnen – Szenarien 2020 für den Wohnungsbestand am Beispiel zweier disparater kommunaler Entwicklungen, Abschlussbericht (unveröffentlicht), IÖR, Dresden.

[2] UBA (2204) Nachhaltiges Bauen und Wohnen in Deutschland. Stoffflussbezogene Bausteine für ein nationales Konzept der nachhaltigen Entwicklung - Verknüpfung des Bereiches Bauen und Wohnen mit dem komplementären Bereich "Öffentliche Infrastruktur", Texte / UBA 01/04; Berlin: Umweltbundesamt, 2004, 160 S., Anhänge.

[3] Deilmann C., Gruhler K., Böhm, R. (2005) Stadtumbau und Leerstandsentwicklung aus ökologischer Sicht, Oekom Verlag, München, 103 S.

Site managers – Is training necessary?

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Because of the diverse nature of the work of site managers a flexible training programme is required to reflect the different levels of experience and qualifications of potential trainees. Although not all site managers need to be formally trained, site management training aids the management of change and innovation in the construction industry and would have a direct impact on the performance of the sector in terms of productivity, efficiency, and quality of output. Trained site managers could be instrumental in improving labour relations and conditions of employment in the construction industry.

Keywords: training, site managers

1. The lack of formal training for the complex role of site manager

In terms of developing human and physical resources investment in human capital in the UK construction sector has generally lagged behind training in other industries. As a result the majority of site workers in the construction industry learn on the job rather than in college or on structured apprentice training schemes. Although training courses are available throughout the UK, (some in dedicated training centres), and the Construction Industry Training Board – Construction Skills operates a grant-levy system for training, formal skills training penetration of the building workforce has remained a low percentage of the workforce in many skill areas.

One example of a group of construction workers with a low percentage of formally trained individuals is site managers, who are at the centre of the construction process. They manage day to day production and are given responsibilities for site safety, security, quality of output, co-ordination of specialist contractors and are expected to deliver their projects according to a predetermined time schedule. To do this they need to have a number of skills and a wide knowledge of construction technology. Nevertheless many construction managers undertake the role without specific site management training or qualifications.

Consequently the industry has a poor reputation for timely delivery, quality and safety. In view of this image of the industry, a survey was conducted to identify the requirements of a modern site management training course. The Chartered Institute of Building currently organise a Site Management Education and Training Scheme in the UK to meet this need, but this paper reports on a survey relating to a course that had been run by the CITB – Construction Skills until the end of the last century. This was undertaken as part of a review and updating of site management training. Although only a relatively few interviews were conducted a pattern in the responses emerged though of course this is not a statistically significant sample. The survey shows there is support for formal training in site management, based on the need to professionalize the image of the construction industry to attract and retain labour.

2. The site management training priorities

The survey covers priorities of training providers and those working in the industry from site to board room level. These priorities relate to the functions of site managers and the study shows broad agreement between training providers and those from the industry and indicates the emphasis site management training courses might be expected to provide.

The most important areas of site management were found to be co-ordinating and managing subcontractors and site labour, leading and motivating team members and dealing with emergencies on site. Of the key functions, understanding the technical requirements, specifying and controlling budgets, and giving specialist guidance and advice were seen as less important.

One suggestion to emerge from discussions concerning site management training involves improvement and change management. Training of site managers should encourage site managers to question continually the way operations are carried out on site with a view to continuous improvement and innovation.

3. The obstacles to training

However, one of the obstacles to site manager training is the opportunity cost of time spent on a course away from work. As regular attendance cannot be guaranteed, trainees in employment tend to participate at best on a sporadic basis or fail to complete a course.

Because firms may not be willing to lose a member of the site management team for a week, an alternative form of course delivery could be based on trainers visiting firms so that site management courses could then be held in-house.

Computer and on-line learning techniques were not seen as necessary on this course by most of the respondents but could be considered in future developments of the course. Nevertheless a dedicated website with knowledge and information would be useful.

Although there is an emphasis on gaining formal qualifications for site management, it is not necessary for all site managers to be formally trained. It was argued that site managers with a craft background often have the necessary experience to become successful and effective site managers.

4. Conclusions

Because of the complexity of their role there is a need for site managers to be flexible and this should be reflected in their training. Courses need to cater for different levels of experience of trainees and the large variety of projects.

Nevertheless, there appeared to be a common consensus that a new site management course should aid the management of change and innovation in the construction industry. It could improve the performance of the sector in terms of productivity, efficiency, and quality of output and in terms of the workforce. Trained site managers could then be equipped to improve labour relations and conditions of employment in the construction industry.

References

[1] Dainty, A.W.R.J., Cheng, M.I. and Moore, D.R. (2003) "Redefining performance measures for construction project managers: an empirical evaluation" in *Construction Management and Economics* **21**, 209–218

[2] Dainty, A.W.R.J., Cheng, M.I. and Moore, D.R. (2004) "A competency-based performance model for construction project managers" in *Construction Management and Economics* **22**, 877–886

[3] Djebarni, R., (1996) "The impact of stress in site management effectiveness" in *Construction Management and Economics*, **14**, 281-293

[4] Farrell, P. and A. Gale, (1998) *Career Progression Paths for UK Site Managers,* COBRA, RICS

[5] Farrell, P. and A. Gale, (1999) *The need to remove ambiguity from the role of construction site managers*, COBRA, RICS

Management of execution phases in a building process using information technologies (IT)

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The analysis in the actual research deals with the management of the execution phases in a building process: starting from the research of new solutions useful to the process actors in controlling the site. The site, connected both to the new building actions or retrieval actions, is, nowadays, a continuous information source, whose flow is influenced by all the actions put into effect by the different actors in an execution phase of the process. The site system is poly – structured as a consequence of various skills in action, of the huge volume of data to be checked and of the legal complexity; so the actors should have a very specific management skill useful to solve problems. For this reason the research aims to find a management structure able to use IT (Information Technologies) in order to offer management means.

Keywords: management; maintenance; quality; control; building site.

1. Introduction

It is extremely important that the building industry, on an international level, should reorganize the productive process and the relationship among the different phases and various actors in order to improve time and costs control, the results testing skills in the name of quality and safety. The building area tends to emulate more and more the other building manufacturing areas, acknowledging the process representation systems and process management, considering that these systems often use IT. In the building system it is necessary to be present in all the phases of the building process, but above all in its middle phase, that is to say the executive one, that nowadays uses less management systems on information platforms. The use of IT should deal with the integration of the information process and data over all the cycle of the product and communication management among the different actors" [1]. The research addressed itself towards a possible integration with the building yard in order to help to increase the profitability of the building area and to obtain an efficient system" [2]. This work is a proposal of a platform for controlling yards, called Site Control System, which consists of a data base useful to gather and manage the obtained information and concerning the site; this system has been tested on some sample sites. The proposed solution wants to help the control activity on information coming from the executive phase in the building process with an open approach to further developments.

2. The information flow and the relationship among process actors

The representation of the information flow inside a building process, as regards this research, has been described using a circular structure going directly in the building management phase. This kind of representation shows how an eventual difference, as regards the information between the two routes, causes real problems into the final product management. During the building executive phase lots of information can be produced; and if this is not listed and managed exactly, we could have as a consequence a lower quality of the building. In fact in some links among the process actors, the information flow occurs in a not codified way and we cannot find fixed link platforms. We thought it was necessary to make the data transmission system standard: that is to say to create a virtual place where it is possible to exchange process information and to gather data. In this research we considered necessary to centralize the data related to the whole process into a unit, through a new representation of the whole process, called "information system" which gathers the data related to the whole living process of the handmade product. The proposed schematisation reduces the channel of the information flow, getting in this way the data coming from the functional areas joined into the data base (archives) which shows the building and gathers all the alterations and changes under the works. Such a defined scheme is necessary in order to make the information flows fixed, apart from addressing the applying of information and particularly the data base shaped information. We tried, therefore, to approach a possible description of the building process to a scheme closer to the functionality of the IT and Data Base systems. In the executive phase and the site one the information coming from the planning phase is "interpreted" by different actors; it is therefore necessary that the information and the data arrive correctly, so that the quality of the process and of the final product is certain" [3]. The proposed model used to describe the site and its information flow is characterized by the site informative system as the centre; so that it becomes the place where information is sorted out; the site in the new representation is considered as the virtual informative system useful to coordinate its related data flows and concerning the work to be built. We worked in order to define the site not only as a receiver of information and data coming from the planning, but also as a generator of new information, brought back modified by the other process operators. The passage of information, in this case, like the check and test functions, does not occur between two single figures, but between every single actor of the process and the informative system, by allowing, therefore, the data diffusion as wide as possible in addition to the fast increases of the mistake and alert messages.

3. The site control system

The research aims to consider again the site process according to lights and attitudes typical of informative procedures in order to change this area by improving quality and profitability[4]. We think that a building made according to the digital process schemes should be a digital building, where the environment check and management functions and their maintenance will be made digital; the same approach followed in the building execution will be useful as basis of its management. The research pointed out some items to be processed: the need of linking correctly the planning phase with the work execution one; the chance of updating the data of the system and the will of suggesting readable systems and easy to be used . The study gained a first operative result, that is to say the definition of requirements an informative system should have: To absorb the information coming from the planning phase; to show the developing operative phases; to identify electronically the objects and the used materials; to compare the works process with what planned in the project; to have the functions of an open integrated data base; to give representations CAD of the whole building (Building information model); to allow the operators to communicate; to supply the next management phase with information in order to implement the planning information with that coming from operation. Such a planned system bases itself on a data base whose interface is a schedule for input data; the data base is set like a digital representation of the same site; in fact as the site receives and produces information from the different process characters, in the same way the data base manages the input and output information. The filling in the schedule gathering data foresees the input of the taking date and the identifying site data: all those are connected by the system to the other information managed by the software, so that it can be considered as the main Data Base key. One of the greatly innovative developed aspects is the structure thought for managing the photographical archives perfectly integrated with the other data; in fact the system allows to link the visual work representation (photos) with the technical information (graphical works). And bringing innovation into the site management causes the activation of positive mechanisms in order to change all the building system. We ended the research, turned to the planning and the making of a system for monitoring the building sites using IT, with a testing phase of the system.

4. Conclusions

This actual research brought the location of a gap inside the management of process information: the site. Then an information instrument was made in order to manage the different phases of the site. This instrument allows the different actors to monitor continuously the working phases. Particularly the system works by increasing the information coming from planning using data as result of the site workings and by giving to the same information a photographical representation of the working state. All the data are realized into the archives, which can be considered as an informative instrument linked to the building and thought as support of building maintenance and management plans.

References

[1] ALBINO Vito, COSTANTINO Nicola, SIVO Guido Le costruzioni,: mercato e impresa, Carocci Roma, 2000.

[2] ANTONINI Ernesto, Costruire con le tecnologie dell'informazione, Themes from Technological Focus Saie 2003, DEI, Roma, 2003.

[3] RIGAMONTI G., La gestione dei processi di intervento edilizio, UTET, Torino, 2001.

[4] MECCA Saverio, Comprendere il cantiere, Edizioni ETS, Pisa 2002.

INCLUSIVITY: The changing role of women in the construction workforce

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The under-utilisation of human resources dependent based on gender patterns is of economic and social concern especially for an economy with an ageing workforce. The paper will look at the bigger picture, grounding the changes within the construction sector over the years to where it stands today, in order to develop a deep understanding of the changing role and need for women in the industry. This research will be an important advancement in the subject of inclusivity and assess the real barriers women face today.

Keywords: Inclusivity, gender, recruitment, training and retention.

The UK's construction industry is facing a skills shortage that is a threat to the long-term health of the industry. It is suffering recruitment problems with its traditional source of labour - young men aged 16-19. Efforts are being made to recruit women into the workforce, but with limited success. In the short term, the industry is filling the skills gap using workers from low wage economies. What is needed is a skilled workforce that sees its long term future in the UK construction industry. To meet the challenge of the skills gap the recruitment of women is no longer simply a nice thing to do; it has become a necessity.

Women in the UK construction industry currently account for under ten per cent of the workforce, reflecting their under representation in an industry that fails to attract and retain women.

Career sexism is an important issue for government, industry, employers and individuals. Occupational segregation is damaging the UK's competitiveness by contributing to the gender pay gap and preventing it from benefiting from the talents of a balanced workforce. The under-utilisation of human resources dependent on gender patterns is of economic and social concern especially for an economy with an ageing workforce.

Whilst recruitment remains important, there is a knowledge gap in translating qualifications into employment, and employment into retention. This is described by the 'leaky pipeline' concept.' Attraction by itself is not the key to increasing women in the construction workforce. Recruitment must be followed by induction of the new employee in order to improve retention levels. Job satisfaction as a result of opportunities and promotion is more likely to retain staff – see figure 1.

For women of older age groups/mature women, part-time and flexible working, the real barrier is the balancing of work and family life, just like other industries

Figure 1 The complete recruitment and retention process

Women occupy junior and supporting positions within high status professions [1]. The "glass ceiling", the situation where women can see, but not reach higher level jobs and are prevented from progressing in their careers, still exists in many occupations and industries, including design and construction. There are very few female Chairpersons or CEOs of architectural, design engineering, or major construction companies in the UK.

For a number of years women have been moving into professional work such as law, accountancy and medicine, all of which require high-level qualifications and are considered attractive because of the perceived high level of social status. Today, numbers of women and men are almost equal in these sectors. But occupational sectors, such as engineering and construction, have not seen a corresponding change in the makeup of the workforce [2].

The paper is divided into six sections. The first section gives an introduction to the topic, an overview of the construction industry, basic statistical data and the need to incorporate more women in the industry. The second section gives statistical data of women in the UK with regards to population, economic activity and education. Section three describes the current position of women in the labour market and the construction industry.

Section four takes a look at the changes in construction industry particularly in process and technology. Section five reviews perceived challenges to women and the complexities of the issues of women in the construction workforce. The final section explores the myths and realities about the industry.

The research method undertaken is a secondary analysis of the literature review and existing studies. The research review is multidisciplinary examining social and psychological factors influencing the culture and environment of the construction industry. Extensive use has been made of work undertaken by Equal Opportunities Commission (EOC), Construction Industry Training Board (CITB), Department for Education and Skills (DfES) and relevant organisations, involving secondary analysis of census data, especially demography, economic activity, employment, educational choices and segregation and segmentation.

This research is important because it raises the debate about the advancement in the subject of inclusivity, assessing the real barriers faced by women today and discussing means of redressing the balance to improve the inclusivity of the industry. Expanding inclusivity, which includes attracting and retaining more women in the construction sector, is a key priority for the UK and many overseas construction sectors. In countries facing skill and labour shortages, increasing the number of women in the workforce would go some way to solving the problem.

The myth is that the construction industry is all about the site and the head office; in reality it is highly fragmented with a long and complicated supply chain in offsite prefabrication and manufacturing sectors. The difficulty in mapping the jobs that the construction sector entails makes the statistical figures of women in the industry unreliable. The tendency is to look at a small picture of the industry, those like the architectural, engineering, and surveying professions and the constructions trades like electrical and plumbing or in areas of management, where the low percentage of women is apparent.

Construction employers will have to implement creative solutions, such as retraining to update skills, flexitime, part-time working, working from home, and job sharing in order to recruit and keep much-needed female employees across all levels of construction work and improve inclusivity.

The Women and Work Commission [3] recommends that the Department of Trade and Industry (DTI) and HM Treasury examine the case for fiscal incentives targeted at these SMEs. In response to this, the 2006 Budget [4] announced a package of measures to enhance lifelong learning opportunities for women in training and work. Funding is for doubling the number of existing Skills Coaching pilots to 16 Jobcentre Plus and the number of pilots delivering level 3 skills, with an additional pilot focused on helping women return to work; and helping Sector Skills Councils in industries with skills shortages to test new recruitment, training and career pathways for over 10,000 low-skilled women. The construction sector especially SMEs that form a major part of the construction industry, disadvantaged by additional costs involved in setting up flexible or part time employment should take the opportunity and funding to get more women into construction.

In summary, the important issues are:

- Attracting more women to the industry by not only focusing on young entrants but also returnees to work following a career break, and those who seek a career change
- Retention of women in the workforce
- Understanding the extent of women employed in the whole industry, including the supply chain.

References

[1] Dainty, A.R.J. (1998) "PhD thesis: a grounded theory of the determinants of women's under achievement in large construction companies.", PhD. thesis, University of Loughborough

[2] EOC (2004) "Plugging Britain’s skills gap: challenging gender segregation in training and work"

[3] Women and Work Commission (2006)."Shaping a Fairer Future." Construction industry – a way forward."

[4] HM Treasury (2006). Budget 2006. A strong and strengthening economy: Investing in Britain’s future.

The role of users and contexts in innovation

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The role of users and the significance of different contexts of use is an often overlooked aspect of studies of innovation and diffusion. Focusing on a piece of 3D CAD software – BSLink – four small case studies are used to examine the processes of its implementation in different contexts and the tailoring done by users to embed the software into working practices. This not only results in different practices of use at different locations, but also transforms BSLink itself into a proliferation of BSLinks-in-use. The debates ensuing during an open day for BSLink users hosted by the software's developers further reveal the gaps between different users' expectations and ways of using the software, and between different BSLinks-in-use, and the often contradictory demands this places on its further development. In these cases, there is no clear cut distinction between activities of innovating and of diffusing.

Keywords: Innovation, diffusion, CAD, users, context.

1. Introduction

It is often assumed that innovation and diffusion are discrete activities, with innovation being the development of a new idea or technology, and diffusion its spread from the developer's studio into the real world. However, this suggests that users, and the contexts in which they are situated, have little effect on the innovation itself. Although this might accurately describe some cases, in others this distinction is much less clear cut. Especially in software, development can be an on-going process, in which users can play a part, for instance as beta testers or as first or 'lead' users.

But what kinds of effects can users have on a particular innovation, and how significant might these be? In order to begin to address these questions, the empirical focus here is on the implementation of a piece of software – BSLink – in four different organisations to examine the ways in which it is being diffused and used. BSLink is a 3D building services modelling and drafting add-on for the ubiquitous AutoCAD. The software allows users to model interconnected systems such as pipe or ductwork runs in three dimensions, either through modelling from first principles or by using an expandable library of standardised components or blocks. Using the expandable library of objects, complex systems such as air conditioning or water heating and distribution can be modelled using accurate representations of real components, precisely situated in 3D space. This model can be added on to or integrated with other architectural and structural models in AutoCAD formats to facilitate spatial coordination and used to show contractors the layout of complex areas in 3D.

The advantages offered by modelling in 3D are that the various components of the overall design can be put together as a 'virtual building' and through a process of 'clash detection' any dimensional inconsistencies between different elements can be spotted and rectified before fabrication or on-site construction. This technique of electronic coordination of the construction design process has the potential to reduce or even eliminate coordination errors, which, if only discovered on-site, can have significant time and cost implications.

2. The users

Four case studies were conducted in the CAD departments of large construction organisations. The organisations were a large design firm (OrgA), a specialist M&E contractor (OrgB), a specialist pharmaceutical facility designer (OrgC) and a large contractor (Org D). In each case, BSLink was being utilized in different ways and to solve different problems. In addition, the consequences and challenges of implementation were different. Where OrgA could use in-house designers to generate the necessary information to build a 3D model, they had little influence over its use on-site. OrgD experienced the opposite; as a contractor it had more influence over implementing 3D models on site, but struggled to get the necessary information from upstream design firms. OrgB could produce 3D M&E models, but getting 3D models from other disciplines to coordinate these services with was a problem. OrgC have developed BSLink as part of a suite of client-oriented visualization tools; a very different use as compared with the other firms, but which largely bypasses problems over getting required information from others, and dispenses with the need for 3D models to be utilized on site.

One of the most striking aspects of the cases is their diversity. BSLink has been adopted to overcome a variety of different challenges, has been integrated into different strategies or approaches to doing construction work, and is located in different spaces within the overall construction process. Different problems of implementation and use are also being experienced. But also, crucially, different sorts of activities are springing up within these organisations to try and make BSLink fit into that specific location.. In OrgA and OrgB BSLink is a solution to a problem of complexity of designs, and part of a new way to coordinate design information within projects and between firms. In OrgD it is a central part of a strategy to increase profitability and efficiency. In OrgC it is a much more bounded tool with limited impact on the construction coordination process as a whole.

3. Four contexts, four BSLinks-in-use

In each case, BSLink is seen as a solution to a problem of how to improve the way that construction design information is coordinated, communicated and distributed. But rather than providing such a solution these implementations of BSLink in fact reveal and even exacerbate a number of problems with the way that construction design information is produced, represented, combined and transferred. By requiring information from engineers and designers earlier on than is usual or expected in the process, problems of getting this information outside of the implementer's own organisation, either vertically (i.e. between building services and structures design) or horizontally (i.e. contractors getting information upstream from designers) were exposed. By requiring that the eventual models are unwaveringly reproduced on site, the activity of interpreting 2D schematics and converting these into 3D is shifted from the on-site workers to the CAD drafters. On-site work then becomes the exact replication of (3D and virtual) models, rather than the use of workers' skill and judgement to convert a 2D outline into a real, 3D building.

4. Clashes in development

The multiple and divergent consequences of each case begs the question of what happens when otherwise discrete organisational contexts come together? The collaborative nature and project basis of construction work requires inter-organisational cooperation. In other words, firms have to work together on specific projects. It is precisely this requirement of collaboration, coupled with the limited spheres of influence of individual organisations which can be seen as a main contributory factor in the problems experienced by the four firms in implementing BSLink, and 3D CAD based coordination strategies more generally. So what happens when these different contexts interact? How are these distinct BSLinks-in-use reconciled?

Six months after the initial case studies were conducted, BSLink's developer held a 'focus group' day for its users. The event was designed to provide a forum where users could provide feedback about problems with the software, and discuss potential future upgrades, extra functionality and areas for improvement.

When discussing future development some fundamental disagreements between different users were exposed. Some wanted BSLink to incorporate the ability to directly drive fabrication machines, but others were uninterested in this, and positioned BSLink as a design and drafting tool only. Some argued for a fuller and more detailed library of specific blocks from suppliers catalogues; others argued that a library of generic and less detailed blocks was more desirable. Another contest was over the additional data that could be included with each block, for instance manufacturers part codes and costs, which would allow the automated production of materials orders, but again this was resisted by some as it moved BSLink away from being purely a tool for representation of design information. Ultimately, the developer was unable to distill these debates into a coherent plan for further development. Unnecessary or diverting new features for some users were essential additions for others. How specific users were positioned within the debates was derived, at least in part, from the contexts in which they worked, and grounded in their interpretations of what BSLink should be, and what it should do.

5. Conclusions

In the cases described, users and contexts of use play highly significant roles not only in implementing or diffusing BSLink but also in innovating - in developing the software's functionality and utility. This means that what and where the boundary is between activities of innovating and diffusing becomes hazy and unclear. But it is clear that users are innovators, not just the subjects of a process of diffusion of a fixed and finalised artefact. They provide ideas for the developer for further functions or applications and, perhaps more significantly, in appropriating and tailoring the software to their own ends based on their own expectations and ways of working situated in their particular contexts, they transform the software itself into a range of unique BSLinks-in-use.

A typology of benchmarking systems

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In the wake of quality assurance, benchmarking and key performance indicators have been emphasised as an effective strategy to improve productivity and stimulate innovation. During the last decade much work has been done to establish key performance indicators for the performance of both buildings and companies within the construction and real estate cluster. However, focus has been put on finding the "right" indicators whereas the institutional and organisational setting of the benchmarking schemes has been largely ignored. The objective of this paper is to examine a number of benchmarking schemes in use in Denmark in order to provide a generalised typology of benchmarking schemes within construction and real estate. This typology will not only be of academic interest but also of interest to authorities and other actors who wants to introduce or reshape benchmarking schemes.

Keywords: Benchmarking, key performance indicators, politics, markets.

1. Introduction

Three trends can be identified in relation to benchmarking within the construction and real estate cluster:

- First, individual studies have been conducted within a wide range of subjects.
- Second, various models for benchmarking have been developed.
- Third, a number of benchmarking schemes have been implemented around the world.

As pointed out by Garnell & Pickrell [1], we need to reflect on some of the fundamentals or institutional settings in which benchmarking schemes operate. Hence, in this paper we will develop a typology of benchmarking schemes that reflects the institutional settings of the benchmarking scheme.

2. Methodology

An extensive literature survey and case studies of four existing Danish benchmark systems have been used as methods in the present study.

3. Benchmarking between politics and markets

Benchmarking as defined by e.g. Camp [2] tends to treat benchmarking as a market-based activity closely linked to the individual company. However, when we look at the development of various benchmarking schemes around the globe (see Bakens et al. [3] for an overview) it becomes clear that benchmarking schemes operate in many different ways in various contexts. In some countries like Denmark, at least some of these benchmarking schemes are directly instigated by governments as a regulatory or coordinating mechanism designed to deal with market deficiencies. Thus, developing a typology of benchmarking must take into account how benchmarking is linked to the interplay between politics and markets.

Analytically, we can distinguish between public and private modes of organisation, and between profit and non-profit modes of organisation [4]. With these two analytical distinctions in mind, four separate ideal typical modes of organisation come to the fore.

	Private	**Public**
Profit	Mode I: Privately owned companies	Mode II: Publicly owned companies
Non-profit	Mode IV: Private organisations	Mode III: Public service and authorities

Source: Adapted after [4].

Figure 1. Four modes of organization.

4. Four examples of benchmarking systems

In Table 1 we will use these four modes of organisation to characterise four different types of benchmarking schemes. Although the examples given below are primarily Danish, we are confident that they represent examples also available in other regions of the world. It should be emphasised that none of the examples can be considered to be pure examples of the four modes of organisation since each example to a varying degree include elements from other modes of organisation.

Table 1. Examples of benchmarking systems.

	Business model	**Association model**	**Service model**	**Government model**
Example	Xerox Corporation (Camp 1989)	Danish Facility Management - key	The Benchmark Centre for the Danish Construction Sector	BOSSINF
Mode of organisation	Mode I	Mode IV	Mode II	Mode III
Affiliation	Private	Semi-private	Semi-public	Public
Profit orientation	Profit	(Non-)profit	(Non-)profit	Non-profit
Purpose	Search for industry best practices that lead to superior performance	Collect, process and publish KPI's * within facility management	Improve quality and efficiency within the construction sector	Monitoring of building cost and public expenditures
Coverage	The business areas of the company	All types of building, but administrative facilities mostly	All types of building projects	Social housing projects
Target group	All levels in the company	Facility managers	Contractors (and government clients)	Government and social housing companies
Access to data	Company (and partners)	Members only	Restricted	Public
Financing	Internal	Subscription	Service charge (differentiated)	Free
Incentive	Improve company's competitiveness	Knowledge sharing	Marketing and access to governmental projects	Mandatory

- KPI: Key performance indicator.

5. Conclusions

In conclusion, benchmarking schemes can be grouped in four ideal types depending on their relative position on a scale from fully market controlled to fully government controlled schemes:

- *The business model* is a private and profit-oriented mode of organisation, where a company has established a benchmarking scheme fully controlled by the company itself. Access to data is usually very restricted since they are considered to be a competitive advantage.
- *The association model* is a semi-private and (non-)profit mode of organisation, where a group of companies and/or persons have formed an association to run a benchmarking scheme. The scheme may be open to all interested actors but access to data etc. is only granted through membership.
- *The service model* is a semi-public and (non-) profit mode of organisation, where the benchmarking scheme is strongly dependent on public regulation. In principle the use of the benchmarking scheme may be voluntarily, but non-compliance or non-use of the benchmarking scheme may invoke different kinds of sanctions.
- *The government model* is a public and non-profit mode of organisation, where the use of the benchmarking scheme is mandatory due to public regulation. Although the government could be running the benchmarking scheme itself, a private operator may also be running the scheme.

References

[1] Garnett, N. & Pickrell, S. (2000). Benchmarking for construction: theory and practice. In: *Construction Management and Economics*, Vol. 18, 55-63.

[2] Camp, R. C. (1989). *Benchmarking. The Search for Industry Best Practices that Lead to Superior Performance.* Milwaukee, Wisconsin: ASQC Quality Press & White Plains, New York: Quality Resources.

[3] Bakens, W.; Vries, O. & Courtney, R. (2005). *International review of Benchmarking in Construction.* PSIBouw, The Netherlands.

[4] Klausen, K. K. (1989). Den tredje sektor. Frivillige organisationer mellem stat og marked. In: Klausen, K. K. & Nielsen, T. H. (eds.). *Stat og marked. Fra Leviathan og usynlig hånd til forhandlingsøkonomi.* København: Jurist- og Økonomforbundets Forlag.

The co-construction of clients, concepts and companies

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In recent years, there has been a repeated call for the client as a driver for change of the construction industry. How the client is to become a driver for change has, however, only been dealt with in the broadest terms. Using single-family housing as case, this paper will explore the role of clients in shaping the concepts and innovative strategies of companies and vice versa. Based on the preliminary analysis, this paper proposes three hypotheses to be explored in the work to follow: First, users may be considered to be multi-centred users. Second, three different concepts of single-family houses may be identified: Branded products, ad-ho-products, and competition products. Third, companies within single-family housing are innovative when it comes to products, processes and services.

Keywords: Innovation, drivers for change, industrialised housing, users, single-family house

1. Introduction

In recent years, the policy and research efforts in both Denmark and abroad e.g. the Danish policy on government building projects, the proactive strategy of CIB on revaluing construction and the establishment of an International Construction Clients Forum (ICCF) has emphasised the role of the client as a driver for change in construction. However, little effort has been put into understanding how clients have in fact been a valuable contributor to reforms in construction. In the following we outline our theoretical departure and our preliminary empirical observations.

2. Three perspectives on users

The study has identified three main strains of theoretical perspectives on users, which contribute to a better understanding of the user as a driver for change.

Innovation management, which emphasises the user as a source of innovation. Within the demand-pull model, von Hippel has been highly influential in showing the importance of lead users in the development of new technologies [1].

Science and technology studies (STS), which emphasise the mutual shaping of users and technologies. The point of departure is that technical objects and social relations are bounded together and that actors and technology are co-constructed [2], [3].

Everyday life studies, which emphasise how users are dealing with technologies. Focus is on the users' domestication of technologies: the users' purchase of technologies, the development of practice in connection with the products and the symbolic integration and adaptation of the product in daily life [4].

2.1 Three types of concepts

Looking at the various types of single-family houses available in Denmark, three broad categories of concepts tend to stand out in our preliminary analysis.

The first category of concepts is the branded products. These are familiar and well-recognised single-family houses with rather fixed designs and floor layouts leaving only some rooms for the end-users to influence the design e.g. by choosing kitchen elements etc. The house builders will usually include the whole value chain (development, marketing, production etc.) in the company or have entered into long-term strategic partnerships with their suppliers.

The second category of concepts is the ad-hoc products. In this category we find a number of companies that operate with rather open-ended solutions. The companies are more likely to operate as developers or construction managers being able to manage the building process for the user rather than delivering a pre-fixed product. Thus, it may be fair to consider producers of ad-hoc products as more process-oriented than product-oriented.

The third category of concepts is the competition products. In some situations, a municipality or client will call for a competition in order to have new ideas developed for single-family houses. Competitions and demonstration projects are likely to be considered especially by architectural firms as a way of promoting them rather than necessarily bringing the ideas into actual use.

2.2 Multi-centred users

Within single-family housing, the client will typically be a non-professional one-time client with hardly any previous experience of building. However, from a functional point of view the one and same actor now has to deal with at least three different roles in one: As a client, owner and customer.

First, as a client the user has to deal with not only the erection of the building but also continuous maintenance, repair work and re-building – some of which is even done as do-it-yourself (DIY) activities.

Second, as an owner (or owner in the making) the user will have to consider issues related to financing often through mortgage loans, taxation schemes, and the potential sale of the building sometime in the future. Clearly, the issue of financing is also a very important precondition for users to become users at all. If the mortgage institution is not willing to lend you the necessary money, you will become a non-user.

Third, as a customer the user will address issues of identity, security, neighbourliness etc. Studies have demonstrated how residential neighbourhoods are associated with different symbolic values and how these values influence the choice of home [5].

3. Innovative companies

Although the branded products differ in level of details, design options etc., the design and production of branded products has much in common with mass-customised production. The mutual shaping of branded products by companies and clients have resulted in product innovations like flexible modularised concepts, process innovations like "co-builder" schemes, and service innovations like new schemes of guarantees. Thus, a toolkit approach to users appears to be prominent but strongly overlaid with scripts by the house builders of the intended use and users.

In relation to ad-hoc products, the design and product development process has a close resemblance with the building process generally. The major difference to common building projects seems to be linked to the initial land acquisition and close strategic relationship to investors whereas the relation to the designer may be weaker. The end-users are seldom directly involved in the design and product development but various schemes for supplementary choices of the individual user will usually be offered by the developer. Instead, the end-users are indirectly represented in the process – may that be through the perspectives or scripts attributed by the investor, developer or designer. Thus, a spokesperson or script approach seems to be dominant in relation to the development of ad-hoc products.

In relation to competition products, the situation is a bit different since a number of the developed products don't get built. Others may be built but only in small quantities. In many cases, the target of the competition products is not necessarily the end-users but instead the jury of the competition. Consequently, the end-users are seldom directly involved in developing the competition product. Instead, the end-users may be indirectly represented.

4. Conclusions

We would like to draw three preliminary conclusions on the mutual shaping of clients, concepts and companies:

Concepts: The mutual shaping of single-family houses by companies and clients have resulted in product innovations like the branded products, the ad-hoc products and the competition products

Companies: The producers vary between house builders, developers and architects. They all innovate, but they follow different innovation strategies.

Clients: Users related to single-family house building may be considered as *multi-centred users*. That is, users of single-family houses hold multiple perspectives or focal points that are time-dependent in two ways since they are coupled to the life-cycle of the building as well as the life-cycle of the actor.

References

[1] von Hippel, E. (1986). Lead Users: A Source of Novel Product Concepts. *Management Science*, 32 (7), 791-805.

[2] Bijker, W. E. & Law, J. (eds. 1992). *Shaping Technology/Building society – Studies in Sociotechnical Change*. Cambridge, Massachusetts & London, England: MIT Press.

[3] Oudshoorn, N. & Pinch, T. (eds. 2003). *How Users Matter. The Co-Construction of Users and Technologies.* Cambridge, Massachusetts & London, England: The MIT Press.

[4] Sørensen, K. H, (1991). *Informasjonsteknologi eller Integrasjonsteknologi? Om teknologi-sosiologiske tilnærminger og deres relevans for analyser af telematik.* Trondheim: Trondheim University. STS-Workingpaper 6/91.

[5] Bech-Danielsen, C. & Gram-Hanssen, K. (2004). Home-building and identity – the soul of a house and the personal touch. Bech-Danielsen, C., Jensen, O. M., Kiib, H. & Marling, G. (eds.). *Urban Lifescape.* Aalborg: Aalborg Universitetsforlag, 140-158.

Evolution of production management methods in construction

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The inability of some production management methods to deal with contemporaneous production management issues, such as material flows, value generation, pull system techniques, human aspects, etc, are responsible by catalyzing failures in construction projects. As a result of this paper we will be delivering a critical and historical literature review of the production management methods and the requirements and expectations that construction managers should have from these methods in their future projects. Production management theories and two case studies are used to support the findings.

Keywords: Evolution, methods, production management, theory.

1. Construction industry background

Many studies presented in the literature pinpoint that the construction industry suffers from a lack of efficiency if compared with other industries; e.g. manufacturing. High levels of waste and unpredictable projects in terms of delivery, time, budget, profitability and standards of quality are expected to give the construction industry one of the worst public images among the industrial sectors. While the introduction of power tools and new materials has led to some improvements, no significant changes in productivity in construction have been observed over the last several decades. Koskela [1] furthermore argues that *'the managerial principles in use in the construction industry in general lead to bad control and unfavourable design, leading in turn to waste and value loss ... management efforts in construction are centered on task management and based on principles of the transformation concept, and principles related to the flow and value generation concepts are largely neglected',* explaining construction performance problems.

This paper objective is to do a chronological literature review of the main production management methods in construction. It is also used the production management theories and two case studies carried out in UK companies to support a critical analysis.

2. The history of production management methods

The most usual production management method in construction is the Critical Path Method (CPM). The CPM is a network technique that had its origins from 1956 to 1958 in two different problems of planning and control in projects in the United States. In one case, the US Navy was concerned with the control of contracts for its Polaris Missile programme. Whilst the contracts comprised research, development and the manufacture of component parts never before made, they could not accurately estimate cost and time of the contracts. Because of this uncertainty, contracts had to be based upon probability. Contractors were asked to estimate their operational time requirements on three bases: optimistic, pessimistic, and most likely dates. These estimates were then mathematically analyzed to determine the probable completion date for each contract, and this procedure was referred to as 'Programme Evaluate & Review Technique' (PERT). The PERT techniques allowed reducing the Polaris project length by over two years. In a second parallel programme, the CPM was developed as a result of a joint effort by the DuPont Company and Remington Rand Univac in 1957. The group had a Univac I computer at its disposal and decided to evaluate the potential of computers in scheduling construction work. Mathematicians worked out a general approach, believing that if the computer was fed information on the sequence of work and the length of each activity, it could generate a schedule of work. This original conceptual work was revised and the resulting routines became the basic CPM [2]. In the following year (1958) the CPM approach was tested in two projects and was hailed as a success. These projects required that both time and cost be estimated and thus became a more definitive approach than that used by the US Navy (PERT). One reason for the massive acceptance of CPM in construction is because the software for CPM is also widely diffused and sophisticated. A criticism about CPM is that its emphasis on managing and controlling activities neglects the issues of material flow management and the creation and delivery of value.

Another, less widely diffused method used in construction is the Line of Balance (LOB). LOB is a linear technique originally developed by the Goodyear

Company in the early 1940's; it was further developed by the U.S. Navy Department in 1942. LOB was first applied to industrial manufacturing and production control, where the objective was to attain or evaluate a production line flow rate of finished products [3]. It was later developed by the National Building Agency (UK) for repetitive housing projects, where a resource-oriented scheduling tool – that considered resources as the starting point – was believed to be more appropriate and realistic than one that was more activity-dominated. The Line of Balance method proposes that activities should be planned within their production rhythms; in other words, the number of units that a crew can produce in a determined time unit. These rhythms are represented in a graphical format which shows clearly the production rates of the various activities against time. LOB has been successfully used as the principal scheduling tool in construction companies in Finland, Brazil, Australia, etc, where it has been used to improve the production flow in the projects involved. On the other hand, some authors indicated that this technique was designed to model simple repetitive production processes and, therefore, does not transplant readily into a complex and unpredictable construction environment.

Network and linear scheduling techniques are deterministic approaches, what becomes difficult to be used because of uncertainties inherent in the construction processes. In the last decade novel production management methodologies have been developed to enhance planning, control, and improvement of construction projects, such as Critical Chain, Last Planner System, combined CPM/LOB, etc. These quite new methodologies have been applied successfully by some companies and should be the focus of attention by the construction industry as a whole.

3. Theory of production management

According to the present understanding of production management, it is divided into two main theories: theory of production and theory of management. The theory of production supports that there are three views to production, each providing for a number of principles for the production system: *transformation*, *flow* and *value generation* – TFV [1]. On the other hand, the theory of management consists of particular theories for *planning, executing,* and *control*. Although some advances are noticed in this theoretical field, only small progress is observed in production management methods that should be compatible with these theories.

4. Expectations

Traditional production management in construction focuses mainly on setting and meeting the targets. Here, management at the operations level is seen to consist of the creation, revision and implementation of plans. A criticism about this type of management is that the plans 'push' tasks to execution without taking the status of the production system into account. It leaves the tasks of management essentially uncoupled from everyday activity. The reality is that the existing production methods are not able to satisfy all the requirements of production management. What could be noticed in the case studies is that the construction industry is using bygone production management methods, or is using them in a wrong context. This generates great amounts of waste as the methods are not always the most appropriate to treat the particular production situation. Others difficulties related to updating a logical sequence of activities and visual management were also observed in the methods used. This underlines that the methods are responsible for management failures in construction. Although newly introduced lean construction based methods, such as the Last Planner System, have been applied successfully in the construction industry, the majority of construction companies are still using inadequate methods to manage.

A theory-based production management method should be targeted in research and development. The development of a method that covers all the theory of production concepts is needed; i.e. transformation, flow, and value. For this to become possible, an understanding is required of how each one of these theoretical concepts behaves as such and how they interact mutually on-site.

References

[1] Koskela, L. (2000) *An exploration towards a production theory and its application to construction*. University of Technology: Espoo-Finland. p. 296.

[2] Kelley, J.E. and M.R. Walker (1959) *Critical-Path Planning and Scheduling*. In Eastern Joint Computer Conference. Boston, MA.

[3] Arditi, D. and O.B. Tokdemir (2003) *ALISS Project*. 03/04/03 [Accessed 25/05/06]; Available from: http://www.iit.edu/~aliss/history.htm

From organization to actor: clients and users needs of facilities in the health care sector

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This paper presents a study on the process of providing premises and its result with regard to meeting the clients′ expectations. A small number of Swedish public real estate companies have been transformed into service organizations. A discussion whether to use a real estate organizational form or a service organization is rooted in the increased demands of achieving efficient and usable buildings satisfying the users' needs. Two main questions were set up in this pilot study: i) In which way does the organization form or structures impact the process of providing premises? and ii) How does the way of organization impact the individuals' possibilities to act in the process of providing premises? The purpose of the study presented is thus to analyse the role of the organizational form and the individuals possibilities to act in the process of providing premises in terms of how they achieve fulfilment of expectations regarding usability for the health care core business. The results from this study indicates that a successful project, by means of meeting the clients′ expectations, do not depend on the organizational form or structure in the providing organization. The study is based on interviews and the result shows that all of the interviewed actors mean that the form of the organization has little direct impact on the result of the process of providing premises; it is how the actor views their work tasks that make the difference for the result. On the other hand, these views depend on the fundamental values in the organization.

Keywords: health care facilities, process of providing premises, actors, continuous briefing and usability.

1. Introduction

The issues raised in this paper are important and relevant to better understand how to provide facilities within the health care sector. As the health care sector is continuously adopting their buildings and facilities to their activities, these processes and the organizations carrying these out need to be efficient. The purpose of the study presented is thus to analyse the role of the actors in the process in terms of how they achieve fulfilment of expectations regarding usability for core business.

1.1 Background

A previous study [1] showed that one of the reasons why projects sometimes do not meet expectations is the lack of; continuous planning, briefing and participation, by the actors from the core business throughout the traditional phases of the construction process.

According to the results from the previous study, this study was created aiming to find out what factors can remedy these shortcomings. An early assumption for this study was that the ability to meet the client's expectations was depending on how the organization providing premises was organised. An initial question in this investigation was therefore whether it is more likely to manage to continuous plan for future project together with the core business, if organised as a service organization, than it would be in a deliver orientated real estate organization. A following question was what impact changes in organizational form have on the companies providing facilities concerning the ways of how they view the clients and the users' needs. Is the change from a deliver orientated real estate organization to a service organization merely a play with words, or does it leads to a profound change of views on processes, clients and users?

2. The case study

Västfastigheter is a real estate company in the western region of Sweden own by the county that provides premises to the health care in the region. The western region is divided in four geographical districts. The district of Gothenburg, the largest one of them, contains primarily three large hospitals. An ongoing study focuses one of the hospitals, Sahlgrenska University Hospital.

As the aim of the study is to find out what the actors in the process of providing premises consider to be the determining factors for meeting the expectations of the healthcare clients', a qualitative and practice grounded method is used. The study is based on interviews, studies of documentation and results from case studies of planning processes for hospitals [1].

This paper, and the study presented, concerns FM issues. In the field of research concerning provision of facilities the literature on Facilities Management, FM, forms a substantial part of documented processes and methods [3, 7, 9].

3. Findings

In this study two main questions were set up. The first question was: i) In which way does the organization form or structures impact the process of providing premises? The results from the study show that all of the interviewed actors mean that the form of the organization has little direct impact on the result of the process of providing premises. The way the process of providing premises is organized is not the most important factor for the result; it is how the actor views their work tasks that make the difference for the result. On the other hand, these views depend on the fundamental values in the organization.

The second question of this study was: ii) How does the way of organization impact the individuals' possibilities to act in the process of providing premises? The results from the study on this aspect, is that not only the competence of the actor but also the competence in the management of the organization are crucial factors for the actors possibilities to make an effective and thorough performance. Some of the interviewers also pointed out the importance of the actor's behaviour, not only the competence. It is mainly a question of relations between the organization and the actors, between the single actors and between the actors and the clients/users.

4. Conclusions

Based on the findings and discussion above, the results are indicating that a successful project, by means of meeting the clients´ expectations, do not depend on the organizational form or structure in the providing organization. In further research it is therefore relevant to study the relationship between the actors' different roles in the process of providing premises.

As the results from question ii) shows, the role of providing premises is developing, buy means that actors now introduced in the organizations have a higher level of competence, in terms of higher education and an improved way of handling the working tasks in the process of provide premises. The management has though more or less still a traditional view of how to handle the process, diverse from the improved way of working some of the actors' uses on an operative level. This unbalance in competence level could be one reason why the actors experience a lack of distinct goals and management.

Another tentative conclusion from this study is that the management relies on the actors and their individual competence. This can serve as a functional system, if the actors work in an organization characterized by teambuilding. If there is not a supporting organizational system, however, this is a weak system. If there is also a lack of common guidelines and policies on how to provide premises, as in most organizations in Sweden, there is a risk to end up in a situation where knowledge and competence is impoverished regarding provision of facilities [12].

In the interviews it was indicated that the result of the process of providing premises is depending on how well the actors are able to interact with each other. The actors interaction on the other hand, seems to depend on the individuals' skills and how the management in an organization can support the individuals.

References

[1] Hinnerson J. (2005) Performance in provision of facilities: A study of buildings in the healthcare sector. *Conference paper to CIB W70 in Trondheim 12-14 June 2006.*

[3] Granath J.Å., Hinnerson J. and Lindahl G. (2005) Case study: Örebro University Hospital: O-building. *Report from CIB TG51 – Usability of workplaces. Swedish workshop*. Gothenburg, Sweden, Chalmers University of Technology.

[7] Abel J. and Lennerts K. (2006) A new method for the fast identification of savings potentials in FM in healthcare. Proceedings to the European Facility management Conference, Frankfurt, 2006. VDE Verlag: Berlin.

[8] Ryd N. (2003) Exploring Construction Briefing: From Document to Process. Doctoral theses, Chalmers University of Technology, Gothenburg, Sweden.

[9] Alexander K., Atkin B., Bröchner, J., and Haugen T. (2004). Facilities management: Innovation and performance. Spoon Press: London

[12] Moss R. (2005) Where do we go from here? Article in Hospital Development Magazine, 10 November 2005. *Published by Wilmington Media Ltd*

Performance metrics for residential building business

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A residential building business performance metrics system is under development in the European Commission funded four year project ManuBuild. The ManuBuild project is targeting to create enablers for a new European wide building construction market. In the final ideal situation enterprises of various sizes would have real chances for joining and contributing to construction business outside their own countries. This is also the main challenge of the proposed business model and relating performance metrics system. Besides to this business vision, the additional main viewpoints forming the basis for the metrics system are community, main stakeholders and customer in particular. It is considered that this can result in the performance metrics solution that can measure the overall added value of building business in an improved way compared with a somewhat more traditional production centered approached. The overall solution is gradually developed by proposing, testing, approving and dropping performance indicators.

Keywords: construction management, international construction business, performance metrics.

1. Introduction

The significance of building construction is widely acknowledged as a major source for the well-being of all people and societies. This kind of very broad definition of the building construction requires a new improved understanding of the performance of building construction and various factors affecting on it.

The European Construction Technology Platform (ECTP) vision is taken as a framework for the ManuBuild key performance indicators. That vision describes Europe's built environment in 2030 being designed, built and maintained by a successful knowledge- and demand-driven sector, well known for its ability to satisfy all the needs of its clients and society, providing a high quality of life and demonstrating its long-term responsibility to mankind's environment.

There's still a way to go to fulfill that vision looking from today's practice. To meet that desired future state the two fundamental development aspects must be addressed: meeting client/user requirements and becoming sustainable. Besides these two major objectives a fundamental and necessary evolution of the construction process itself must be underpinned to diffuse the knowledge on the whole value chain.

2. ManuBuild performance metrics

ManuBuild project develops sustainable value driven business processes. They are addressed for implementing the open manufactured building systems, organizational concepts and models to support and reflect the new processes, and new services covering the whole life cycle of buildings from initiation to demolition, recycling and waste disposal.

Based on the state of the art study, see e.g references [1 and 2] 53 applicable performance indicators are proposed that can be used in residential housing projects to measure the performance of buildings, processes and organizations that are involved in delivering and maintaining them.

The performance metrics serve for validating the conformity of delivered products to the expectations of their users over life span, and for measuring the performance and sustainability of products, processes and organizations (Figure). The ManuBuild indicators act also as valuable input data for Business Intelligence (BI) systems to be used in the integrated ManuBuild business model.

The next step is to select a smaller number of them, e.g. 10 - 12 key performance indicators focusing the value creation to the customer. This performance metrics, or a relevant sub set of it, can then be used together with company's other (production oriented) indicators to deliver ManuBuild buildings with success in the future.

3. Discussion

The traditional building process has been criticized being too much driven by production factors (investment cost and delivery time). The future building process, as described by the wide industrial consortium (ECTP) in their vision 2030 emphasizes meeting customer requirements and becoming sustainable by using a new business model.

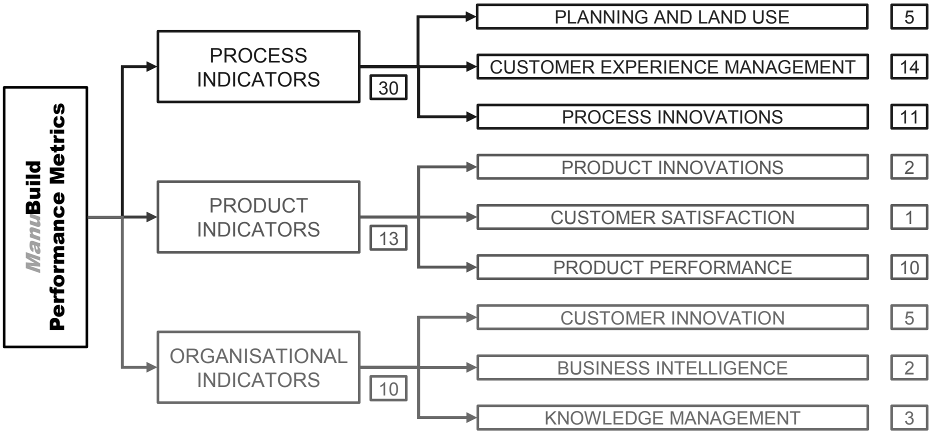

Figure. The main categories of ManuBuild performance metrics

ManuBuild key performance indicators, to be developed from the set of indicators as described here, focus on sustainable value creation to the customers and to the community.

An interesting aspect is the value creation oriented delivery delighting the customer with a positive surprise by achieving more than they expected. This is not a statement towards over quality, but rather meeting the unexpressed, sub-conscious needs or expectations together with other project requirements in a cost efficient and productive way. This seems to be a kind of performance worth noticing when new business models are developed.

One interesting challenge in meeting client requirements is to study which is the level of individually defined requirements that can be met by industrial supply.

4. Conclusions

The selected rather holistic development approach is considered to be of importance for reaching sustainable value driven business processes. This approach comprises process, product and organizational viewpoints. The main target is to meet client/user requirements and become sustainable. Providing positive surprises to customers should lead to customer loyalty and form the foundations to form a profound business brand.

The next step in our research is to select a smaller number (e.g. between 10 and 20) of key performance indicators, develop the suitable measuring methods for each indicator and test those in live building production.

References

[1] ASTM 2000. Standards On Whole Building Functionality and Serviceability. Second edition. American Society for Testing and Materials, West Conshohocken, PA, USA. ISBN 0-8031-2734-0. 280 p..

[2] Porkka, J and Huovila P. (2005). "Decision Support Toolkit (DST) – a step towards an Integrated Platform for Performance Based Building (PBB)". Procs Combining Forces – Advancing Facilities Management and Construction through Innovation June 13-16, 2005, Helsinki, Finland.

Theoretical 52-concept platform for advancing construction-related business management

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A theoretical platform of 52 concepts published in English between the years 1990-2005 is introduced for advancing global and local business management (BM) practices and new enabling BM concepts. The 52 concepts belong to the eight schools of thought on BM as follows: 13 organization-based, 11 Porterian, 10 knowledge-based, 10 dynamism-based, 4 process-based, 3 competence-based, 1 resource-based, and 0 evolutionary concept. For the review, 25 journals, 9 book publishers, and 22 international conference proceedings have been relied upon. Overall, no applied research tradition in BM exists as part of construction-related management research in the OECD countries.

Keywords: Business management, construction, global markets, literature review

1. Introduction

The conduct of this qualitative literature review is reported in detail in [1]. Herein, the purpose is to introduce a theoretical platform consisting of 52 construction-related business management (BM) concepts published between the years 1990-2005. Construction involves design, implementation, servicing, and life-cycle aspects of investments in natural resources usage, energy supply, telecommu-nications, transportation, infrastructure, manufactur-ing, and general building concerns. Dynamism includes a spectrum of static, dynamic, even chaotic, global and local markets and businesses. Hart's [2] literature-review guidelines have been relied upon. The coherent nature of managing a business has been maintained by focusing on the research on firms based in one of the OECD countries. The exception is to include the concepts originating from Singapore or Hong Kong; due to these authors' British Commonwealth heritage and global interests. Over the 16-year period, three publication channels have been relied upon: 25 journals and 9 publishers com-plemented with 22 conference proceedings. Notably, the new concepts that the 9 publishers may have published as part of their books during the years 2003-2005 are not yet taken into account. Three theo-retical questions are addressed in this summary as follows.

2. Theoretical platform

The platform consists of 52 construction-related BM concepts published within 48 references between the years 1990-2005. The authorship consists of 42 (individual, pairs or teams of) authors. There are 72 individual authors. 27 (52 %) concepts have been published via journals, 14 (27 %) concepts as part of the edited books with many authors, and 11 (21 %) concepts within the books by one author(ship). Question 1. What are the frequencies of publishing the 52 concepts across the four fields of construction-related management research? 30 (58 %) concepts are related to construction economics and management, 9 (17 %) concepts to project management, 8 (15 %) concepts to real estate development, and 5 (10 %) concepts to industrial management.

Question 2. What is the relatedness of 52 concepts to one of eight schools of thought on business management? Each concept is assigned to one of eight schools of thought (Table 1). The combined share of the organization-based, Porterian, knowledge-based, and dynamism-based schools is 84 %. Overall, none of eight schools of thought has triggered a coherent flow of construction-related BM concepts.

Table 1. Relatedness of 52 construction-related BM concepts to the eight schools thought on BM.

School of thought on BM	No.	(%)
1 Porterian school	11	(21 %)
2 Resource-based school	1	(2 %)
3 Competence-based school	3	(6 %)
4 Knowledge-based school	10	(19 %)
5 Organization-based school	13	(25 %)
6 Process-based school	4	(8 %)
7 Dynamism-based school	10	(19 %)
8 Evolutionary school	0	(0 %)
Sum	52	(100 %)

3. Targeted business-management problems

Question 3. What theoretical management problems have the authors targeted by their concepts by school of thought?

Among 13 (25 %) organization-based BM concepts: For project-oriented and PM firms, an organizational model is offered by Artto, capability building is enabled by Davies and Brady, a project-based organization is matched with products by Hobday, one-size-fits-all approach is opposed by Turner and Keegan, PM-centred organizations are advocated by Sauer et al., PM offices are supported by Kendall, and a virtual CM firm is designed by Kiiras and Huovinen. For contractors, a successful contractor is envisioned by Flanagan, partnering pillars are designed by Bennett, partnering is customized by Cheng and Li, and a business system is designed by Huovinen. For building products suppliers, a collaborative model is made by Huovinen and Hawk. For real estate firms, a systems-change strategy is designed by Leinberger. The theoretical advancement of 13 concepts seems to be fairly modest. Instead, the practical relevance is fairly high. Better concepts can be integrated with the BM systems in given contexts.

Among 11 (21 %) Porterian BM concepts: Strategic planning is supported by Betts and Ofori. A model for architectural practices is designed by Winch and Schneider. A/E firm strategies are applied by Ve-shosky. Strategies for QS practices are re-defined by Jennings and Betts. Value chains for real estate ser-vices are applied by Roulac. A customer-based pro-ject-success metrics is designed by Pinto et al. Five arenas are chained by Huovinen. Product differ-entiation is addressed by Langford and Male. Low cost, differentiation, and speedy response are linked by Rapp. All Porterian modes are recommended by Kale and Arditi. The applicability of the 11 concepts varies a lot. In part, the authors may not have been allowed to address the applicability via the scientific channels. Porter's chain of causality can be adopted for predicting why a firm's cross-sectional strategy will be (non-)successful at a future point in time?"

Among 10 (19 %) knowledge-based BM concepts: Learning organizations are advocated by Hawk, Love et al., Davies and Brady. Knowledge-based concepts are emphasized by Langford and Male, Robinson et al., Borner, Huovinen, and Walker. Alliances are enhanced by Love et al. Project-portfolio manage-ment is enabled by Anell. The theoretical advance-ment and the applicability vary a lot. Better concepts can be advanced through systemic approaches. Among 10 (19 %) dynamism-based BM concepts: Project BM is advanced by Meklin et al. and Lampel. Corporate real estate, workplaces, and FM services are linked with BM by Barrett, Mitchell-Ketzes, and Osgood. Dynamic construction BM is enhanced by Chinowsky with Meredith, Langford and Male, de Haan et al., and Huovinen. Some of 10 concepts are more theoretically advanced while the others are more pragmatic. It is envisioned that many dynamism-based concepts will be among the most profitable ones by the year 2010. Better concepts can be dynamized to foresee high variance differences inherent in interactions between key actors and markets. New value-based ways can be added to manage a dynamic business successfully.

Among 4 (8 %) process-based BM concepts: World-class or high FM services processes are designed by Kaya et al. and Rogers. Project-based approaches are linked with businesses by Anderson and Merna as well as Morris and Jamieson. The concepts diverge a lot in terms of the theoretical advancement and the applicability. Better FM services and project-based concepts can be designed to exploit direct causal relations with primary BM.

Among 3 (6 %) competence-based BM concepts: Managerial and organizational competences are the primary elements in Huovinen's concept and Lang-ford and Male's approach. Capability assessment is enabled by Trejo et al. The concepts diverge in terms of the theoretical advancement and the applicability as well. More applicable concepts can be designed to enable competence leveraging more effectively.

Within 1 (2 %) resource-based BM concept, four resource categories are differentiated by Lowendahl. The categories seem to be highly applicable to design-business contexts. Sustained success can be achieved through developing the new idiosyncratic ways of managing that are very difficult-to-copy.

5. Conclusions

No applied research tradition in BM exists as part of construction-related management research in the OECD countries. The authors of 52 concepts have added neither very high theoretical contribution nor deep practical value onto the original generic BM concepts. A real 16-year platform may consist of 65-70 BM concepts. In part, the missing 10-15 BM con-cepts will be identified from among the books pub-lished between the years 2003-2005 by the key pub-lishers. Nevertheless, this identified 52-concept plat-form is promoted toward business managers and in-terested scholars alike.

References

[1] Huovinen P. (2003) Firm competences in managing a firm's dynamic business in particular in construction markets. Unpublished licentiate thesis. TKK Helsinki University of Technology, Espoo.

[2] Hart C. (1998) *Doing a literature review*. SAGE Publications, London.

Note: The author submits a list of the publication channels and a list of 48 references containing the 52 concepts on request.

Reviewing conceptual research on the targeted area of construction-related management

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The aim of this paper is to advance the conduct of reviews of conceptual research on the targeted area of managing construction-related firms, their businesses, operations, and alike. The main areas of construction-related management include corporate, business, and operative management, strategic planning as well as management tools and techniques. Conceptual research takes place in four primary disciplines of construction economics and management, real estate development, project management, and industrial management. Conceptual study processes are posited as the units of review. Neutralism guides reviewers to protect their reviews against biases and threats. Future reviewers are encouraged to design their rationales as a set of 10 principles.

Keywords: Conceptual research, construction, literature review, management, unit of analysis

1. Introduction

In general, literature reviews are relied upon as the secondary research method as part of the primary empirical studies. Only a few handbooks have their focus (and scope) on advanced literature reviews as scientific methods in their own right. The aim of this paper is to advance the conduct of the reviews of published conceptual research on the targeted area of construction-related management in firms so that such reviews are conducted as the independent pieces of scientific research. The paper is based on the pioneering concept-review process that the author carried out during the years 1999-2003 [1]. The author has relied upon the same principles for reviewing the additional concepts published between the years 2003-2005 [2].

2. Construction-related management

Construction markets deal broadly with design, implementation, services, and life-cycle aspects of investments in the utilization of natural resources, energy supply, telecommunications, transportation, other infrastructure, manufacturing, general building, and real estate concerns. In turn, construction-related management covers the vast scope of managing all kinds of firms, businesses, processes, functions, interactions, projects, deliveries, and alike in evolving global, international, national, regional, and local markets. The five main areas of construction-related management include corporate, business, and operative management, strategic planning as well as management tools and techniques. Management and leadership are seen as two overlapping spheres such as 'the two sides of a coin'. Herein, the emphasis is on the management side, i.e. managing entities, actions, factors, and topics (that are linked with human resources in one way or another).

3. Reviews of construction-related management research

Concepts are abstractions representing objects, properties of objects, or certain phenomena, e.g. a firm managing its operations in global and/or local construction markets. Concepts are the building blocks of any theory or model in construction-related management research. Construction-related management research takes place within four academic fields: construction economics and management, real estate development, project management, and industrial management. In turn, conceptual research reviews are the independent pieces of scientific research that investigate the published concepts of the targeted area of construction-related management. It is argued that without the identification and the critical reading of the accumulated research it would be difficult for anyone to see how research on construction-related management could produce a new highly advanced concept or make a new highly relevant application of the current one. Hart's [3] handbook includes the basic guidelines for conducting a conceptual research review.

4. Limitations of originality of conceptual reviews

A reviewer can impose the limitations of the potential originality for her or his review of conceptual construction-related management research in terms of setting the basic criteria for eligible concepts and defining the unit of review. First, a reviewer is obliged to ensure that the potential area(s) meet four basic criteria for eligible concepts: the minimal size of the targeted concept population, the economic and societal context, the language(s), and the period (years) of publication. Second, a conceptual research reviewer may address the conceptual study processes of primary authors as a unit of review. A total conceptual study process consists of 10 concurrent, iterative elements (or stages). A particular reviewer may focus on only some, half, or all of them such as: (i) primary authors' reliance of different paradigms of methodology (e.g. naturalism, interpretavism, deconstructionism, participant inquiry, and critical theory) and ontological, epistemological, and methodological assumptions; aligning with Griseri [4], truth is hardly accessible in construction-related management research. (ii) authors' initial reviews of prior assumptions, concept-design processes, and their outcomes, i.e. existing concepts, and (iii) primary authors' current (i.e. most recent) assumptions, concept, and its validity.

5. Aspects of neutralism

Reviewers are entitled to adopt the key aspects of neutralism to protect the validity of reviews from likely biases such as preferring only (a) one of paradigms of methodology, (b) one of research traditions, (c) one of business or market contexts, (d) one way of defining the concept's advancement, and (e) one way of analyzing the concept's applicability. Hart [3] guides reviewers not to judge paradigms of methodologies, but rather to learn from each. It would not take a reviewer far if (s)he attempts to analyze concepts across (inter)national research traditions in terms of each traditions' assumptions, propositions, and evidence. Such one-tradition-reviews result in enhancing only themselves as the biased truth of the matter. If any review-generated evidence reveals differences in achieving success vis-à-vis the targeted concept population, then this reviewer can infer only an association between the higher success and the particular concept(s). Reviewers should let the conceptual data speak and include all eligible studies at the outset. The only circumstance in which the exclusion of studies may be appropriate is when the criteria for excluding studies are defined, ex ante [5].

6. Rationale as ten principles

Future reviewers may design their rationales for conducting a rigorous review of conceptual construction-related management research based on 10 interrelated research-review principles (Table 1). For a review at hand, a reviewer can phase the adoption of these principles according the five logical stages of a literature-review process that serve the functions similar to the ones they serve in primary research: (i) problem formulation, (ii) literature search, (iii) the reading of literature and the evaluation of the data for the inclusion, (iv) the analysis of the targeted references, and (v) report design and writing [3]. In addition, a reviewer may consider the notions of preunderstanding and dualistic approach.

Table 1. Review rationale as ten principles.

(1) Choice of an independent conceptual review
(2) Choice of the targeted area of management
(3) Setting the aims and the limitations of originality
(4) Search for eligible published concepts
(5) Inclusion (retrieval) and exclusion of concepts
(6) Coding, exposure, and analysis of concepts
(7) Assessment of validity of the review process
(8) Discussion of the findings
(9) Suggestions for advancing conceptual knowledge
(10) Suggestions for practicing managers

7. Conclusions

The role of future reviewers of conceptual construction-related management research is seen important. They may gain an inspiration by the idea of becoming a knowledge builder who needs a construction manual to accompany his blueprints and bricks. Finally, this author is aware of the fact that his original design for a house of conceptual research review will remain idiosyncratic to this paper until some other generic or construction-related reviewers adopt, apply, and test the credibility of this house.

References

[1] Huovinen P. (2003) Firm competences in managing a firm's dynamic business in particular in construction markets. Unpublished licentiate thesis in construction economics and management. Helsinki University of Technology, Espoo.

[2] Huovinen P. (2006) Theoretical 52-concept platform for advancing construction-related business management. *Proceedings of Joint CIB W65/W55/W86 Symposium*, Rome, 18-20 Oct 2006. CIB, Ar.Tec. et al., Rome (forthcoming).

[3] Hart C. (1998) *Doing a literature review*. SAGE Publications, London.

[4] Griseri P. (2002) *Management knowledge. A critical review*. Palgrave, New York.

[5] Cooper H. (1998) *Synthesizing research. A guide for literature reviews*. Third edition. SAGE Publications, Thousand Oaks.

Two logics of competition and construction marketing in global and local markets

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Logic of Competition in a construction market is defined as eight competitive arenas. Logic of Construction Marketing is defined as 19 routes coupling these arenas into a value adding chain. For construction marketers, it is suggested that they can set more advanced goals and also attain them by learning these new logics, identifying incumbents and their routes, anticipating changes, deducing non-existing marketing routes and/or inventing the new ones, and (re)designing their strategies accordingly. For scholars, a new unit of analysis is put forth, i.e. a combination of two or more arenas connected via the marketing routes. Collaborative research is called for.

Keywords: Competitive arenas, construction markets, marketing, Porter Michael E.

1. Introduction

The following research problem is addressed: “How can one best capture and understand the logic(s) underlying dynamic (or even chaotic) competition and marketing in evolving global and local construction markets?” The aim is to advance core thinking in construction marketing by defining a new logic of chained competition coupled with a new logic of marketing. The four sub-aims are as follows: (1) To introduce a new unit of analysis, i.e. a chain of two or more competitive arenas with marketing routes in the focal context, (2) to define Logic of Competition in Construction as the eight competitive arenas, (3) to define Logic of Construction Marketing as a set of 19 marketing routes that couple these arenas in duos or trios, and (4) to discuss a need to overcome many weaknesses in construction and some implications both for marketers and scholars.

2. Competitive redefinition of a construction market

Porter’s [1] five competitive forces are redefined to drive competition within several causally interrelated, upstream and downstream arenas inside a market: (1) incumbents in the base arena, (2) bargaining power of clients in the next upstream arena, (3) bargaining power of subcontractors, sub-designers, and suppliers in a set of downstream arenas, (4) threats of substitute offerings and (5) threats of new entrants. Each construction market is divided into causally-interrelated parts or arenas where interactions take place. It is axiomatic that each procurement method, which each client (procurer) chooses, determines the rules of competition and the nature of marketing downstream in the next arena. Each incumbent occupies the two principal roles of a marketer and a procurer in its base arena. As a marketer it interacts via marketing routes with targeted clients in the upstream arena(s). As a procurer it acquires inputs via procurement routes from inside the same arena and from the downstream arena(s). The collective strength of these extended forces determines the ultimate total profit potential and how it is being divided between the marketers/procurers in the connected arenas in terms of long run return on invested capital.

3. Logic of competition in a construction market

Logic of Competition in a construction market is defined as eight interrelated competitive arenas: Arena 1 of uses of building and infrastructure stocks, Arena 2 of ownership and trading, Arena 3 of life-cycle services, Arena 4 of capital investing, Arena 5 of wholes, Arena 6 of parts, Arena 7 of building products supply, and Arena 8 of construction materials supply [2]. New substitute offerings may emerge related to any of arenas, even in the short term, based on better designs, more effective ways of construction and installment, better products or materials, or more advanced services. Global and local entrants start competing in each arena annually. In principle, even globally leading incumbents have latitude to rethink and influence the internal structure and boundaries of the focal arenas and to position themselves relative to other actors [1]. In addition, the various financiers may become direct parties in contracts inside the eight arenas.

4. Logic of construction marketing

Logic of Construction Marketing is defined in terms of identifying altogether 19 marketing routes, i.e. 13 routes that couple the eight arenas and six routes that enable a marketer to win deals also inside its base arena. It is axiomatic that each marketing route, which each client in the chain prefers or accepts, determines the rules of competition in the connected base arenas. By definition, focal marketers have one or more routes connecting their base arena to one or more targeted upstream arenas or enabling their marketing inside the base arena. Next, each of 19 routes is defined briefly as follows:

- Route 1 allows owners and traders of the base Arena 2 to market, rent, and/or arrange access to their objects/stocks to user types in Arena 1.
- Route 2 involves two or more owners and their linked marketing/procuring interactions which result in changes in the ownership of the objects/stocks inside the base Arena 2.
- Route 3 involves providers of the base Arena 3 who are marketing their life-cycle services to owners over the contract periods related to objects in Arena 2.
- Route 4 involves providers marketing life-cycle services to users in Arena 1.
- Route 5 involves focal providers marketing certain life-cycle services to others within the same base Arena 3.
- Route 6 involves capital investors and traders of the base Arena 4 who are marketing their objects to owners in Arena 2.
- Route 7 includes investors and traders marketing their objects to potential users in Arena 1.
- Route 8 involves focal investors and traders marketing certain objects to others within the same base Arena 4.
- Route 9 includes contractors and CM consultants of the base Arena 5 who are marketing their overall solutions to investors in Arena 4 for the realization of an object through a single contract.
- Route 10 involves designers and sub-contractors of the base Arena 6 who are marketing sub-solu-tions, designs, and services as the parts of objects to contractors and CM consultants in Arena 5.
- Route 11 involves designers and subcontractors marketing parts directly to investors in Arena 4.
- Route 12 involves focal designers and subcontractors marketing certain services to others within the same base Arena 6.
- Route 13 involves product suppliers and traders of the base Arena 7 who are marketing their building products, components, construction machinery, and tools to subcontractors in Arena 6.
- Route 14 involves product suppliers and traders marketing their products directly to contractors and CM consultants in Arena 5.
- Route 15 involves focal suppliers and traders marketing certain product types and components to others within the same base Arena 7.
- Route 16 involves materials suppliers and traders of the base Arena 8 who are marketing their materials to product suppliers/traders in Arena 7.
- Route 17 involves suppliers and traders marketing their materials directly to subcon-tractors in Arena 6.
- Route 18 involves suppliers and traders marketing their materials directly to contractors and CM consultants in Arena 5.
- Route 19 involves focal suppliers and traders marketing certain materials to others within the same base Arena 8.

Multi-arena firms are crafting integrative marketing strategies and managing routes across several arenas. Naturally, all the 19 routes allow and enable collaboration between global and local actors.

5. Conclusions

(Inter)national collaborative organizations can incorporate the two new logics into their industry-development programs (e.g. CIB's theme "Revaluing Construction") to overcome weaknesses in competition. Ideally, the highest gains are achieved by those firms who assume and integrate best a dual role of marketing and procuring [2]. It is proposed that the new unit of analysis, i.e. a combination of two or more arenas connected via the marketing routes addresses the underlying fundamentals of competition and marketing that are not dependent on the specifics of a given base arena and the routes that a global or local marketer uses within the targeted market. Interested researchers may validate this proposition.

References

[1] Porter M.E. (1980/1998) *Competitive strategy /with a new introduction*. The Free Press, New York.
[2] Huovinen P. and Kiiras J. (2005) Enhancing procurement across eight Porterian competitive arenas in construction. In Sullivan K. and Kashiwagi D.T., eds., *Proceedings of 2005 CIB W92/T23/ W107 International Symposium on Procurement Systems.* Vol. 1. Feb 7-10, 2005, Las Vegas, USA, 157-165.

Client influence on project planning in the Nigerian construction industry

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Project planning is a very crucial factor in project success as project failure can otherwise be regarded as failure in project planning. Since project planning has such a significant impact, it is expected that clients will show great concern about it. Based on this premise, this paper examines the influence of clients on project planning in the Nigerian Construction Industry.

Keywords: Client business motive, Client type, programming techniques, project plans, project priority.

1. Introduction

Researchers opine that project-planning efforts usually fail to achieve their objectives [1] [2] and when this happens, project goals are jeopardized. Since project planning has considerable effect on project success, high concern about it is expected from clients. This background necessitates evaluating the influence of clients on project planning in the Nigerian construction industry.

1.1 Purpose of the study

The objectives of the study are to determine the level of use and the priority accorded project planning by clients and the relationship between clients and project planning. The aim is to establish whether or not clients have any influence on project planning.

1.2 Variables of the study

Project planning is classified into two variable categories namely: project plans and programming techniques. 14 major project plans and 4 programming techniques are selected for this study. For the purpose of clients, 3 factors namely: clients' type that is public and private, clients' business motive namely: commercial, quasi-commercial and social and the clients' priority for projects namely: low, moderate and top are selected.

1.3 Conceptual framework for the study

The above variables are classified into independent variables namely client type, client business motive and project priority and dependent variables namely: project plans and programming techniques. A framework is developed to express the relationships between the two variable groups.

1.4 Previous studies

Researches on project planning are focused on project planning methods and process [1] [3] [4] [5], the influence of construction firms on project planning [6], the stage of planning before commencement of work [7] and matching project planning with project performance [3]. Little attention is given to clients in previous researches on project planning. This paper is thus directed towards bringing the features of clients into focus in researches and practices of project planning.

2. Research methodology

To achieve the objectives of this study, a survey involving a sample of 21 construction projects selected randomly from the population of completed projects in Nigeria was conducted. Data were collected on the number of projects procured by clients, the frequency of preparation of project plans and the level of use of programming techniques. The frequency of preparing project plans and the level of use of programming techniques were measured using 5-point Likert scale namely: never, rarely, sometimes, usually and always. Structured questionnaires were used to collect data, which were analyzed to determine the level of use of project planning by clients and the relationships between project planning and clients using mean item score, t and chi-square tests.

3. Results

The study reveals that pre-contract plans that is project drawings rank higher than post-contract plans in level of preparation among clients. Architectural and structural drawings rank highest in pre-contract plans while programme of work ranks highest in post-contract plans. Lifecycle chart, cash flow chart, method statement and organisation chart rank least in pre-contract plans while health and safety plan and plant schedule rank least in post-contract plans. The study further reveals that the level of use of all programming techniques is higher in public sector projects than private sector projects. List of activity ranks highest in level of use among clients while bar chart; network analysis and line of balance rank next in ascending order.

The study also reveals that there is association in the ranking of the level of preparation of project plans between the variables of client type, client business type and client project priority. Also, there is association in the ranking of level of use of programming techniques between the variables of client type, commercial and quasi-commercial clients; social and quasi-commercial clients. However, there is no association between the variables of clients' project priority and commercial and quasi-commercial clients.

The study also reveals that there is relationship between client type and electrical drawing; lifecycle chart, cash flow chart and bar chart; between clients' business motive and lifecycle chart, material schedule, health and safety plan, bar chart, network analysis and line of balance and between clients' priority on projects and architectural drawing, mechanical drawing and network analysis. However, there is no relationship between client characteristics and the remaining variables of project planning

4. Discussion of findings

The finding that architectural and structural drawings rank highest in level of use among clients shows that the two plans are the most important plans to clients. The study discovers that life cycle chart is the least important document to clients generally. Since this document is used in managing project delivery time, the result implies that clients in the Nigerian construction industry show least interest in the management of project delivery time.

The finding that list of activity technique ranks highest in level of use is an indication of poor project planning. The finding that there is association in the ranking of the level of preparation of project plans among clients indicates that the priority accorded project plans by clients is the same. The finding on the test of relationship in project planning between the variables in client characteristics indicates that the level of preparation of majority of project plans differs among them. The use of bar chart is the same between public and private sectors clients but those of list of activity; network analysis and line of balance differ among them. The use of bar chart, network analysis and line of balance is the same among social, quasi-commercial and commercial clients but that of list of activity differs among them.

5. Conclusion

This study confirms that clients generally regard architectural and structural drawings as most important and life cycle chart as least important. It also confirms that the level of projec programming is low. The study also shows that the priority accorded project planning by clients is the same but the level of use of project plans differs among the sub-variables of client characteristics. Based on these findings, the paper concludes that project planning in the Nigerian construction industry is inadequate and that clients' interest in the planning of project life cycle is low. To guarantee the success of projects, there is need for the industry to adopt better programming techniques and to improve its level of use of project plans. The situation calls for more concern in project planning by clients. This can be achieved by incorporating project-planning conditions or clauses in prequalification, tendering and contract agreements.

References

[1] Cohenca, D, Laufer, A and Ledbetter, W B (1989) Factors affecting Construction Planning Efforts, Journal of Construction Engineering and Management, ASCE 115(1). 70-89

[2] Laufer, A and Cohenca, D (1990) Factors affecting Construction Planning Outcomes, *Journal of Construction Engineering and Management, ASCE,* 116(1), 135-156.

[3] Idoro, G I (2006) Evaluation of Project Planning for Sustainability in the Nigerian Construction Industry, *Proceedings of a Conference on the Built Environment,* Department of Architecture, College of Science and Technology, Covenant University, Ota, Nigeria.

[4] Kharbanda, O P and Pinto, J K (1996) *What made Gertie gallop? Learning from Project failures.* 1st edition. Von Nostrand Reinhold, New York

[5] Kabasakal, H E, Sozen, Z and Usdiken, B (1989) Organisational context, Structural Attributes and Management Systems in Construction Firms, *Construction Management and Economics,* 7, 347-356.

[6] Faniran, O D, Oluwoye, J O and Lenard, D (1998) Interactions between Construction Planning and Influence Factors, *Journal of Construction Engineering and Management,* July/August, 245-258

[7] Clayton, R (1989) Planning is the key, *Building Today,* 197, 31-33

Client influence on direct labour system in the Nigerian construction industry

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Researchers claim that direct labour which is a prominent procurement system in Nigeria involves high staff strength and overhead expenditure and that this feature erodes the economy it has over contract systems. This paper attempts to confirm this claim by evaluating the influence of clients on direct labour (DL) system in the Nigerian construction industry.

Keywords: Client development motive, client goal, client policy, client project unit, client type

1. Introduction

Researchers regard direct labour (DL) as a prominent procurement system in the Nigerian construction industry [1]. Government and its agencies in Nigeria in the recent past opted to promote DL system because of the realization that contract construction cost was higher in Nigeria than in other countries [2] [3]. Consequently, organized structures in the form of DL units and agencies were set up at both federal and state government levels. Critics of the development maintain that the system is wasteful because it involves high staff strength and overhead expenditure and that it is mainly used for government construction. Favorites of the development however, claim that the system has economy [3]. In the light of this argument, this paper evaluates the influence of clients on DL system in the Nigerian construction industry.

1.1 Aim and objectives of the paper

The objectives of this paper are to determine the level of use of DL system among clients in the Nigerian construction industry and whether or not the system requires high staff strength as claimed. The aim is to establish the use and economy of the system.

1.2 The Variables of the Study

The variables used for the study are classified into two categories namely: client characteristics and level of use of DL system. Client characteristics consist of client type defined as public and private, client goal defined as profit and non-profit, client development motive defined as speculative and non-speculative, client junior, senior and management staff strengths measured in five ranks of 1-20, 21-50, 51-99, 100-999 and $\geq$ 1000, client project unit staff strength measured in three ranks of 1-10, 11-600 and >600 based on the classification of small, medium and large contracting firms, and client project unit organization structure defined as project, matrix and functional structures. The use of DL system is defined by two variables namely: client policy on the use of DL system measured in four ranks of never, rarely, sometimes and always and the number of DL projects procured by clients measured using four ranks of $\leq$ 1, 2-3, 4-5 and >5.

1.3 Previous Studies

Researchers confirm that DL is a prominent procurement system in Nigeria and other countries [1] [4]. On the use of the procurement system by clients, the focus of researchers is on public clients [1] [3] [4]. Little or nothing is reported on the use of DL system in the organized private sector in Nigeria. On the economy of the system, researchers maintain the system has greater economy over other procurement systems [1] [5]. However, critics of the system caution clients on its use.

2. Methodology of the study

To achieve its objectives, this paper adopts a data based approach, which relies on primary data. For this purpose, a field survey is conducted using structured questionnaires. A sample of 120 clients selected randomly from the population of clients in the Nigerian construction industry is used for this study.The data collected consist of the clients policy on the use of DL system which is measured on a 4-point Likert scale of never, rarely, sometimes and always and the number of projects procured by clients using DL system which is also measured on a 4-point Likert scale of $\leq$ 1, 2-3, 4-5 and > 5. The data are analyzed to determine the ranking of the level of use of DL system among clients using mean item score and for the test of difference in the level of use among the sub-variables of client characteristics using t and F tests.

3. Results

The results of the analysis are presented as follow:

i. Public clients favour DL system more than private clients in the two parameters that define level of use.
ii. Non-profit oriented clients favour DL system more than profit-oriented clients in the two parameters of level of use.
iii. Non-speculative clients favour the system more than speculative clients.
iv. The policy of clients with the lowest junior staff strength favours the system most whereas clients with the highest junior staff strength use the system most
v. Clients with the least senior staff strength favour the system most in the two parameters of level of use.
vi. Clients with 100-999 senior staff strength favour the system most while clients with senior staff strength greater than 1000 least favour the system.
vii. The policy of clients whose project units operate project structure favours the system most whereas clients whose project units adopt functional structure use the system most. Clients whose project units operate project structure least use it.
viii. Clients with medium project unit favour the system most whereas clients with large project unit least favour the system.
ix. The test of hypothesis of no significant difference in the level of use of DL system reveals that the policy of and the number of projects procured by public clients are significantly higher than those of private clients. The result also confirms that public clients favour DL system more than private clients.
x. The test of hypothesis reveals that the level of use of DL system by non-profit oriented clients is significantly higher than that of profit oriented clients both in organization policy and the number of projects procured.
xi. The test of hypothesis also reveals that there is no significant difference in the level of use of the system between speculative and non-speculative clients.
xii. The test of hypothesis reveals that there is no difference in the number of DL projects procured by the sub-variables of client junior, senior and management staff strengths.
xiii. The study also reveals that the level of use of DL system by the sub variables of client project unit staff strength and organization structure is the same

4. Discussion of findings

DL system is mainly promoted in Nigeria by public clients therefore increased public investment in construction will translate into increased level of use of DL system and the reverses will reduce the level of use of the system. It is important to state that public clients are non profit oriented in their goal and non-speculative in development. The finding is that clients and client project units with high staff strength do not use the system more than those with low staff strength therefore the use of DL system does not necessarily call for high staff strength and by implication high overhead expenditure. This finding agrees with some research works and disagrees with others. The use of the system is not based on the organization structure adopted. The adoption of project inclined organization structure does not translate into increased level of use of the system.

5. Conclusion

The paper concludes that the use of DL system to a great extent depends upon government investment in construction. A reduction in government expenditure in construction is likely to reduce the use of the system and vice-versa. Another conclusion is that the use of DL system does not translate into high staff strength for client and his supporting project unit and high overhead expenditure. It is further concluded that the staff strength and overhead expenditure arising from the use of DL system does not remove the gains (from contractor's profit and overheads) that accrue to clients when the system is used. In agreement with some researchers [5], this paper concludes that DL system has greater economy over contract systems in the Nigerian construction industry.

References

[1] Iyagba, R.R. and Idoro, G.I. (1995) An overview of Direct Labour Construction in the Declining Economy of Nigeria. *Journal of Construction* 10(4) Jan–April 1995. *The Federation of Building and Civil Engineering Contractors in Nigeria*.. Pp. 2 – 13.

[2] Ministerial Committee on causes of high Government contracts in Nigeria (1982) *Report* .Federal Government Press, Lagos, Nigeria Pp. 5.

[3] FGN (1985) Budget of the Federal Republic of Nigeria. Federal Government Press, Lagos, Nigeria. Pp22-23

[4] Federal Military Government (1985) Views *and Comments on findings and recommendations into the Activities of the Federal Housing Authority 1974 – 84*. Federal Government Press, Lagos.Nigeria.Pp. 10.

[5] Ojo, S O, Adeyemi, A Y and Ikpo, I J (2000) Effects of procurement methods on clients objectives of time and cost in the Nigerian construction industry. *Journal of Financial Management and Propert.y* 5(1&2), Pp 105-108

Leveraging intranets for knowledge sharing and learning within construction alliances

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Intranets are becoming more and more widespread in use as mechanisms for knowledge capturing, sharing, use and transfer. This paper discusses how the Intranet technology could enhance knowledge sharing and capturing within construction alliances. A short case study on the use of Intranets within a multinational construction alliance is presented and the paper details the results and compared with the theoretical findings.

Keywords: Alliances, knowledge sharing, mechanisms, Intranets, collaboration, construction industry

1. Introduction

Alliances are commonly defined as voluntarily initiated cooperative agreements between firms [1]. The main purpose of an alliance within the construction industry context is to share resources and capabilities of the participants so that the necessary and appropriate critical mass is gathered as a means of mitigating commercial risks of construction projects. Alliances in the construction industry have increased both in the UK and internationally due to the volume of large scale construction projects.

Due to the very high emphasis on achievement of the various commercially driven project objectives, the sharing of resources and capabilities between alliance participants is short term orientated in the construction industry. The short term orientation allows limited opportunities for the alliance participants to exploit the collaborative advantage within alliances. The paper contextualises this phenomenon and address how Intranet technologies enable the realisation of long term benefits for construction alliances.

2. Intranets for knowledge sharing and capture

The concept of the Intranet emerged as a result of the need to popularise relevant company details such as performance, policies, the mission, vision etc., to its employees. However, its functionalities have evolved to such an extent that the role performed by an Intranet varies between the passive publicising of up to date company information among its employees to dynamic exploitation of some of its capabilities to integrate with social networks.

To gain an advantage out of the Intranet as a tool for knowledge sharing and capturing, it is essential that it is populated with more dynamic content rather than static company information. As Guenther and Braun [2] suggest, the popularity of the Intranet is a function of its rich content being related to the tasks carried out by people in the organisation. This enhances further participation by the community to enrich its content. Therefore this process energises and is energised by the people who regularly benefit from its knowledge rich central repository. Stodart [3] points out that this process works effectively when the climate within which the Intranet operates is appropriate and promotes the population of the Intranet.

The Intranet technology therefore addresses the needs of construction alliances to extend their short term collaboration to gain longer term benefits. However, the successful uptake of the technology within construction alliances is a function of how it reacts to the specific construction industry challenges that were discussed before. The research issue that is investigated is ‘the degree of appropriateness of Intranets to the specific challenges imposed by construction alliances in their path towards assimilating the technology’. In this paper we focus on whether construction alliances present the climate to achieve the benefits and recommend solutions by conducting a short case study in the construction industry.

3. Methodology

Case study approach is adopted based on the exploratory type and nature of the research issue that is investigated [4]. The unit of analysis for this study is taken as the collaborative links at different levels between the alliance participants. Face-to-face interviews were held with senior managers (SMs) and project managers (PMs) in the case study alliance. Triangulation was achieved between data sources (two different levels in the managerial hierarchy), data collection methods (utilising two different forms of interview guidelines) and data analysis methods (utilising two different forms of data analysis methods). Interviews lasting for more than one hour were conducted with senior managers (SMs) and project managers (PMs).

4. Case study details

XY alliance is a strategic partnering alliance. The contractual agreement between X and Y company is structured in a mutual beneficial way. X company guaranties a continuous workload for Y company over a stated number of years, for which the Y company is set a target of 30% savings over 5 years against benchmarks for construction and maintenance of petrol stations. The structuring of the contract to achieve the targets is driven to employee level by the alliance through setting of individual targets for employees. Due to the nature of the goals set and how they impact on the overall workforce of the alliance, they were perceived by the employees as the short term commercial objectives.

This paper details the use of the Intranet for sharing, capturing and use of knowledge within the UK based team amidst the focus on the achievement of short term orientated goals.

The Intranet was launched in September 2002, which is accessible from any office belonging to the XY Alliance. Use of a web platform for the Intranet facilitates more effective collaborations and knowledge sharing by making available a lot of information for the global team. One of the important services that the Intranet attempts to develop is a web based health and safety management program.

5. Results and discussion

SEs perceived that the level of Intranet usage was significantly low. This has resulted from its lack of information content specific to the tasks performed by the team. Issues of quality of the information stored within the alliance portal were also raised by the SMs. Further, these two issues contribute to making up of alliance participants' level of personal propensities to share information as pointed out by Jarvenpaa and Staples [5]. Therefore the inadequacy of content and lack of quality create a barrier for developing and sustaining of the Intranet use. The reduction in the number of cycles that the Intranet is populated impacts its richness and its utility as a knowledge sharing and capturing tool.

PMs also agreed that the Intranet content was not related to the tasks that they perform and the contents were mostly of static nature.

6. Conclusion

The results of this short case study reveal the potential for Intranets to impact knowledge sharing, capturing and use within construction alliances. The case study results provide the necessary support to the theoretical justification that alliance tasks and activities are overly short term orientated and that there is inadequate emphasis on the use of Intranets to gain long term collaborative advantage. It was also found that the tasks and activities of the people conducted on a routine day-to-day basis do not adequately harmonise with the use of the Intranet, and they perceived that it was an additional task requiring more resources.

As the longer term benefits of Intranets in construction alliances are achieved when their usage is effectively spread among all levels of workers, the activities connected with the Intranet usage should receive the strategic consideration of the alliance management. Further, the senior managers are best positioned to address this need and to ensure that this balance spread is maintained among all levels of workers.

References

[1] Gulati, R. (1998), "Alliances and networks", *Strategic management journal*, 19.4, pp 293 – 317

[2] Guenther, K. and Braun, E. (2001), "Knowledge management: benefits of intranets", *Online*, Http://www.online.com, May / June 2001

[3] Stodart, L. (2001), "Managing intranets to encourage knowledge sharing: opportunities and constraints", *Online information review*, Vol. 25.1. MCB University press

[4] Yin, R. K (2003), "Case study research: design and methods", Third edition, Sage publications, London

[5] Jarvenpaa, S. L. and Staples, D.S. (2002), "The use of collaborative electronic media for information sharing: an exploratory study of determinants", *Journal of strategic information systems*, 9(2/3), pp 129 – 154

Estimating earthwork cost for human settlements

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Earthwork is one of the most important items defining human settlement costs. Besides its importance in terms of cost, the earthwork volume is strongly related to environmental impacts. In this context, this paper proposes indicators to estimate this volume to support design analysis and to take decisions related to costs of human settlements with horizontal houses. Bibliographic review, interviews with professionals that deal with this subject, visits to occupied human settlement projects and data analysis provide the basis to develop a model to estimate earthwork demand based just on the intended use of the land. The paper presents the developed model and shows it can forecast earthwork volumes and costs easily and more accurately than the current approaches.

Keywords: Earthwork; human settlements; costs; environmental impacts; design analysis; indicators

1. Introduction

In order to create better human settlements, low cost house production processes has been looked for. Reducing costs involves both the house production itself and the urbanization implementation. Some researchers and professionals, under the induction of organizations such as United Nations, are nowadays comparing the available alternatives for settlements conception and production; describing supposed best practices; and evaluating real cases in order to define parameters to help decision-making about the subject [1].
In this context, the authors are going through a research that intends to propose indicators to help estimating urbanization costs. In this paper, earthwork is discussed; the proposed indicators can help cost estimation in the earlier phases of the project, helping design decisions in order to keep costs in a lower level.

2. Earthwork for human settlements implementation

One of the most important factors related to cost and environment impacts of human settlements implementation is the volume of necessary earthwork. In spite of this, in accordance to Luiz Eduardo de Oliveira Camargo (the president of Associação das Empresas Loteadoras do Estado de São Paulo – AELO, wich is an organized association that gathers together and represents enterprises and professionals dealing with land subdivision and urban development), “in Brazil, nowadays preliminary estimating of earthwork volume is based on a technical visit to the terrain and it depends on the experience or sensibility of the professional who estimates if earthwork will be simple or complex”.
Based on the professional impression, it is possible to use the indexes published by technical magazines to forecast earthwork demand. *Table 1* shows indexes for earthwork that are published by such a type of magazine in Brazil.

Table 1. Urbanization costs indexes [2]

Urbanization Cost – earthwork item	
Earthwork demand	**Cost/(US$*/1000 m^2 of useful land)**
Small earthwork	286,18
Medium earthwork	992,16
Big earthwork	2757,19

This model probably leads to big errors on the earthwork cost estimating as it will be demonstrated later.
So, considering the impacts on landscape, on the environmental conditions and on the housing costs, the authors considered to be necessary to have a more accurate model to forecast earthwork demand.

3. Understanding earthwork and the influencing factors

The following factors were described in the paper as important in defining earthwork demands: the slope rate of the land surface; the lots frontages, their depths and if they are positioned parallel, orthogonal or oblique to the highest slope of the land surface.
The dependent variable (or the “result” of the process, as described before in this paper) was measures by the following indicator: Earthwork/Land Area= (amount of fill material + amount of cut material)/Land Area.
In order to evaluate the influence of the factor on the earthwork demand, the authors used a sample of case studies consisting on 53 Brazilian human settlements with horizontal houses, which were promoted by CDHU (a public company in Brazil).
Figure 4 in the paper allows a first analysis about the relationship between land slope rate and earthwork volume per area. The increase of the slope rates makes earthwork volume higher. But terrains with slope rates smaller than 2.5% presented more expressive earthwork than those with these rates in between 2.5 and 15%. The results are in accordance with the literature.

In order to search for an estimation approach, the earthwork volume (the independent variable) was considered in relation to the lots and the roads areas, by means of the following indicators:

- Lots Earthwork/Lots Area = (amount of fill material on lots+ amount of cut material on lots)/Lots Area.
- Lots Earthwork/Roads Area = (amount of fill material on roads+ amount of cut material on roads)/Roads Area.

The other previously described factors (lots frontage, depth and position) were also considered in the model, as showed by Table 2. Notice that the values 8m and 20 m are considered to be representative limits between two different conditions for low income houses in Brazil. Table 2 and Table 3 define groups of conditions the authors believe induces different earthwork demands; the cells were filled with data coming from the case studies.

Table 2. Earthwork volume estimation (human settlement name = m^3 of earthwork/ m^2 of lots) and inducing factors

Terrain Slope	Position of lots is predominantly				
	Orthogonal to the highest slope		Parallel to highest the slope		Oblique to highest slope
	Lot Depth		Lot Frontage		
	≤ 20m	> 20m	≤ 8m	> 8m	
< 2,5%	0.82		0.31		1.17
2,5%≤i<5%	1.28		0.19		0.41
5%≤i≤10%	----	0.92	0.60	0.37	0.75
10%<i≤15%	1.10	1.60	---	1.08	1.36
>15%	2.81	1.50	---	---	2.75

Table 3. Earthwork volume estimation (human settlement name = m^3 of earthwork/ m^2 of roads) and inducing factors

Terrain Slope	Position of roads is predominantly		
	Parallel to highest slopes	Orthogonal to highest slopes	Oblique to highest slopes
< 2,5%	---	0.73	---
2,5%≤i< 5%	---	0.41	0.57
5%≤i≤10	---	0.35	0.76
10%<i≤15%	---	1.58	1.49
>15%	---	1.95	1.83

In order to compare the estimation provided by the proposed model (Table 2 and Table 3) and the present Brazilian approach, the authors calculated earthwork cost, for a housing settlement that was not used to develop the proposed model, using both approaches.

The Brazilian human settlement for low-income people used for the comparison has the following characteristics: 75 isolated houses; Lot Frontage is 10 m; Lot Depth is 20.68 m; Land area is 26819.45 m2; Lots area is 15506.30 m2; Roads area is 6792.42; terrain slope is 3%; lots and roads areas predominantly oblique.

According to Table 2 and Table 3 the earthwork demand for lots, in this case, is 0.41 m^3/m^2, and for roads is $0.57m^3/m^2$. Conforming model the total cut-and-fill is $10229.26m^3$.

Based on a survey realized on earthwork services prices, the cost of cut-and-fill forecasted by the proposed model is about: US$16367. This value has to be added to the cost of terrain levelness and clearing of vegetative. Then the total cost is US$43991.Using the same unit costs to real values, the total cost would be US$40924.00 (7% different of the model cost).

Considering the indexes of Table 1 in the paper, the total cost of earthwork for this example would be US$15385 (62% different of the real cost).

The model proposed by the authors seems to be very easy to use and, in this first comparison, provided an estimated figure very more close to the real value than the traditional approach adopted in Brazil.

4. Final comments

The presented model will be submitted to specialists to get their opinion on it and to support further improvements. The authors believe the model can be useful not only to forecast cost before the design completion but also to help design directives definitions.

Other urbanizations tasks are being evaluated using a similar approach and the authors believe the final models will help designers and managers to take better decisions in order to get to housing solutions that gather together both higher quality and lower costs.

Acknowledgements

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References

[1] CEROI (Cities Environment Reports on the Internet) (2000) Understanding the CEROI template. Cities Environment Reports on the Internet, Arendal. pp. 12.

[2] Pini (June 2005) Índices&Custos. *Construção Mercado.* No 47. pp. 6

Activity suited buildings: Decision-Making-Model for flexibility

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Activity-suited buildings create effective processes in a business. An adaptation has a limited time perspective, and premises need to change over time in order to keep up with processes in buildings. In an ideal situation, owner, clients and users, based on a demand for quick adaptability, would be able to transform the building when needed. This places high demand on adaptability in a building, ie flexibility. There are factors that can be pointed out which control the flexibility of a building. The study is both to provide a categorisation of the "Flexibility Factors" and to provide a tool for decision-makers to deal with adaptability in buildings.

Keywords: Flexibility, Adaptability, Decision-Making, Flexibility Factors.

1. Flexibility

The word "*flexible*" is defined in dictionaries as: pliable, adaptable, supple, easily moved, capable of change, changeable. A flexible building is a building that can easily be adapted to future activities, with flexibility defined as the possibility of changing and adapting a building to changes in its activity through the physical and administrative environment [1].

The object was to develop a decision model and illustrate the effect of the various factors on flexibility in buildings. A survey was used to indicate which factors respondents thought most important in this context. A literature study was carried out to collect information on the subject and to add depth to conclusions and statements.

2. The need for flexibility

Buildings are produced chiefly to cover a need for localisation of activities. It is usual for buildings to change over time, but unusual for these changes to be planned, and so overall strategies for simplifying changes are needed [2]. The conditions that exist to take well-grounded decisions for the future have been studied through literature searches and questionnaires.

Each year, a smaller part of the total property stock is complemented through new building [3]. A similar amount of area is also estimated to be made newly available by being rebuilt and adapted to new activities. For this part, it is of major financial significance that sites can be adapted to new requirements without extensive, technically complicated, and expensive measures. The question of flexibility has been brought into focus because an increasing number of schools are rebuilt to changed needs. Some existing investment has not been suitable for these new requirements. Another example can be found in municipal sites where the need is changed from pre-school to group accommodation for those suffering from senile dementia over time. Costs can be avoided if sites are suitable for adaptation without extensive technical measures. From a municipal and socio-economic viewpoint, there are advantages in more flexible sites, to build and administer sites over the total building life. An increasingly flexible viewpoint should increase the possibilities of using the nation's property more effectively [4].

3. Factors that affect flexibility

From the literature studies, a number of factors which may be regarded as affecting flexibility have been identified. The factors have been ranked on the basis of the replies to the survey that was carried out, and a model of how decision-makers should take account of flexibility has been developed. They indicated that the factors that affect flexibility, "*flexibility factors*", are decisions that involve:

1) production,
2) material standards,
3) installations,
4) finance,
5) awareness,
6) planning for the future

4. Survey result

The study was based on literature surveys and a questionnaire sent to the largest property-owners in southern Sweden. The survey asked various questions on and around the subject of flexibility. The result of the survey seemed to be a normal distribution.
The response frequency for property owners was 48%, and 2% of respondents replied that they did not wish to take part. The whole survey was prepared digitally and answered via an e-mail link and send out to a total of 52 property owners. In fact, the selection of possible participants in the survey could not be higher and at the same time retain local orientation. Digital questionnaires carried out by e-mail often

have a lower response frequency than ordinary questionnaires, so the response frequency in this particular survey can under the circumstances be regarded as satisfactory.

Although a high response frequency guaranteed that property owners actually answered as the result of the study showed, this was done by analysing the results using factor analysis. The analysis showed by factor analysis the same result as previously presented, ie that the results of the survey reflected the total results of the study. The relevance of the statistics and the result can after these tests be regarded as confirmed.

5. Decision model

A building planned for future changes should be sufficiently flexible to provide the conditions for easier reconstruction [5]. The required level of flexibility depends on what sort of activities might occur in the building over its service life. The decision model is thus based on an understanding of the factors that affect flexibility. The level of flexibility, ie the level of flexibility that the building has at a particular point in time, need not be high if the building will not be changed over its service life. Where a building is reconstructed in the future, there should be a higher level of flexibility, on a par with the magnitude of the changes, to provide simpler possibilities for reconstruction.

Decision-makers should therefore through their increased understanding more easily get hold of what may happen to a building in the future and thus not cut off the building from a particular activity, but should strive after perfect flexibility for the building (ideal flexibility). It is however possible that ideal flexibility may prove to be no flexibility at all, if the building is not to change over time. But an increased possibility for change may stimulate change and then ideal flexibility does not mean an inflexible building.

6. Conclusions

Flexibility in buildings must be provided only when there is a need for flexibility. The level of flexibility required is unique to each individual building, ie, it is high in certain buildings and non-existent in others, depending on future requirements and initial conditions. According to the study, awareness aspects, financial aspects, and installations are the factors that most affect flexibility, while planning for the future, production, and material standards have least effect. But the fact is that all aspects affect flexibility to a great extent, and there is a small difference between the effects of the various factors.

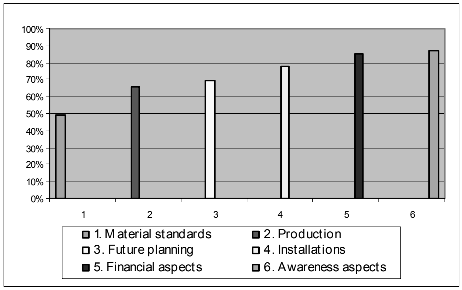

Figure 1. Respondents' rating of how various factors affect flexibility of a building according to the survey.

The intention of the study was to give decision-makers an increased understanding of the factors that affect flexibility in buildings. A decision model has been created that indicates the factors and the extent to which they affect flexibility. By understanding these factors, a more effective use of buildings can be promoted. Increased flexibility in buildings gives added value, and the ability to provide for fluctuations in the use of buildings is good for the national economy.

References

[1] Greden, L., De Neufville, R., Glicksman, L., 2005, "*Management of Technology Investment Risk with Real Options-Based Design: A case study of an innovative building technology*", Massachusetts Institute of Technology, MIT, pp.8.

[2] Slaughter, S., 2001, "*Design strategies to increase building flexibility*", Building Research and Information, 29(3), pp. 208–217.

[3] Statistics Sweden, SCB the 24th February 2005, http://www.scb.se/templates/tableOrChart_29305.asp.

[4] Sumer, A., 1997, "*Flexibility Management: The ultimate strategy*", Industrial Management, 39(1), pp. 26-31.

[5] Moravek, J., 1996, "*Preventing future shock in today's buildings*", Consulting-Specifying Engineer, 20(5), pp. 28-32.

Informal employment in the construction sector - a review of its effects

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Construction is characterised by a high percentage of informal employment. In developing countries, it can account for as much as 80% of employment [1]. As a percentage of a country's GDP it is significant - 40% in developing countries and 18% in the OECD high-income countries [2]. Many researchers criticise the validity of measuring informal employment because of its lack of economic theory and unreliability of data collection [3] [4]. Informal employment is an important and complex issue, understanding its impact on construction is the main focus of this paper.

Keywords: informal employment, construction

1. What is informal employment?

Informal employment (IE) is not well understood and very little research work has been undertaken on it in the construction sector. The many adjectives used to describe IE tend to precede the nouns "economy" or "sector" but this is misleading as the phenomenon does not exist on its own. It is better understood as part of an employment continuum from informal to formal [3]. It changes over time according to economic, social and political pressures with many people working both formally and informally throughout their working life. It is all employment that is not formal and can be split into several different categories ranging from illegal activities to work for which there is no formal arrangement such as childcare.

2. Measuring IE

IE can be measured directly or indirectly. Many researchers believe that it is growing, particularly in the developing world, but there are huge problems in the methods of measurement, particularly for construction. This is because of 1) the unreliability of the data; 2) the perspective of the measurement, and; 3) construction being treated as one sector. IE is seen as a problem for all EU Member States, who are committed to taking preventative action to eliminate the phenomenon and see a real need to measure the extent of the problem.

Unreliability of the data: Data collection is inherently difficult as those working informally are unlikely to want to 'own up' to their activities as many of them are avoiding taxes, costly bureaucracy and regulations, or are fraudulently claiming state benefit. There are two forms of measurement: direct and indirect. The direct approach is through micro surveys or voluntary replies to tax audits. The main drawback is that any respondents that are unregistered or unregulated will not reveal all of their sources of income.

Indirect measurements include the discrepancy method where input and output are compared, for example, income and expenditure, or labour accounts. Eurostat considers this indirect method to be useful in reconciling national accounts but states that it has a number of disadvantages when assessing the volume of IE in terms of labour units. Two more indirect methods are the demand deposit ratio method and the transaction approach. There are several problems with these approaches particularly that not all IE is paid for in cash [5]. A widely adopted approach is the use of very small enterprises (VSE) as an alternative non-monetary proxy.

Models are a more comprehensive measurement of IE, recognising the different variables such as: real and perceived tax burden, the burden of regulation, tax immorality, the rate of unemployment, and per capita disposable income, male participation rate, hours worked and growth of real GNP. Although modelling is more comprehensive than the other forms of measurement, its use of a large number of variables can lead to a high degree of uncertainty and unreliability in the results.

Perspectives of measurement: There are many different perspectives from which IE is measured. For example, a survey commissioned by a tax authority will set out to identify the level of tax income lost through informality. Labour organisations such as the International Labour Organisation (ILO) are concerned with human rights and worker welfare. Any analysis of the different forms of measurement needs to take into account the 'lens' through which the data is seen and understood.

Construction features highly in national and international surveys of IE as it constitutes a large part (46%) of all informal work according to Pederson's [5] study of the UK. However, many statistics treat the construction sector as a homogeneous entity, whereas, in reality, it is made up of a number of sub-sectors for example, design and engineering consultants, construction enterprises, manufacturers and suppliers and general service providers. In capital-intensive parts of the sector, such as civil engineering, there is little opportunity for IE. However, house-building gives ample opportunity as it is labour intensive. There are many other examples of informality across the supply chain.

3. IE and construction

IE in construction means different things to different people. Therefore it is useful to have a framework to understand it in construction. An economic-social-political (ESP) framework is used in this paper.

Economic: Much of the research into IE is based on economic factors. There is an economic bias in many of the methods of measurement yet some researchers challenge their validity as they have no basis in economic theory. Many economists see IE as having a negative impact on the economy, yet over 60% of the money earned informally is spent in the formal economy, representing positive economic activity. In times of booming construction activity, formal employers rely on sub-contracting/informal workers to meet increased need for labour. It is estimated that the 2012 London Olympics will create 33,500 extra construction jobs; many of these will use IE.

Social: A job is more about what a person is than what a person does. The social aspect is very important in the networks formed by those in IE. Contacts made in the process of formal employment often provide opportunities for informal work. Once established, people or small organisations work informally and rely heavily on personal contacts/networks. The ILO considers IE as unrecognised, insecure and unprotected and so people working informally are more at risk because of a lack of adherence to health and safety regulations and lack of education and training. Yet, construction employers agree that IE is important in providing short-term cover, meeting peaks in demand and resourcing one-off tasks.

4. Political factors

Many government policies are based upon the national statistics, however, if the measurement of IE cannot be relied upon, this distorts the construction (or any) output figures. Without accurate figures the government will have little guidance for its policy making. The loss of tax income and benefit fraud are major concerns of governments around the world, particularly in developed countries; in a developing country, it is a thriving informal economy that stifles the growth of a structured tax and social security system, yet it does not stunt economic growth.

5. Putting informal employment into context

The dominant government policy in most countries is to deter IE through prevention (regulations and registration) and detection systems. Many of the deterrent measures used are aimed at work in the repair and maintenance of residential property. For example, France, Italy, Denmark, Finland, the Netherlands, Italy, Luxembourg, Sweden and France have used targeted tax initiatives. There are also a wide range of supply-side solutions that attempt to move people from informal to formal employment, such as reducing bureaucracy and encouraging voluntary disclosures.

6. Conclusions

The construction sector has traditionally used non-standard forms of employment such as self-employment and sub-contracting, and, with work practices changing, there is an increase in sub-contracting and so more opportunities for informal working. On one hand this causes concern for the government in terms of lost tax revenue, and the industry in terms of health and safety and training. On the other hand, the industry relies heavily upon sub-contractors and self employed people, many of whom work informally.

IE is commonplace in the construction sector, it is complex and is difficult to measure. It involves more than just economic factors; it embraces people's need to have a place in the "socially ordered division of labour". Therefore, understanding the complexities and effects of IE is vital for a sector that relies so heavily on it. With that understanding will come new ways of dealing with what many see as a 'problem'.

References

[1] Farrell, D. (2004). The hidden dangers of the informal economy. The McKinsey Quarterly.

[2] Schneider, F. (2002). Size and measurement of the informal economy in 110 countries around the world, World Bank.

[3] Harding, P. and Jenkins, R. (1989). The myth of the hidden economy, Open University Press, Milton Keynes 202p.

[4] Williams, C.C. and Windebank, J. (1998) Informal employment in the advanced economies, Routledge, London ISBN 0-41516960-7, 222p

[5] Pedersen, S. (2003), The shadow economy in Germany, Great Britain and Scandinavia. A measurement based on questionnaire surveys. The Rockwool Foundation Research Unit, Copenhagen.

Challenges when developing tools for measuring construction excellence: a Swedish case

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Tools for measuring excellence have been used for long time in many industries. The American Malcolm Baldridge Award initiated an international development of numbers of tools to support and strengthen improvements within individual companies (permanent organizations) and to stimulate improvements on national level. As a parallel, the British Constructing Excellence initiated the developments of tools focused on performances within construction projects (temporary organizations), but also with dual aims: to support construction projects with data for improvements and to stimulate general improvements on national level. This paper presents a number of challenges met in the development of such a tool within Swedish construction. The Swedish tool is currently under development and is planned to be implemented in 2007.

Keywords: Performance measurement, construction projects, benchmarking, Sweden

1. Introduction

Based on a number of governmental initiated investigations and the debate within the sector, a group of organizations including Swedish Council for Constructing Excellence (BQR), Chalmers University of Technology and Swedish Institute for Quality (SIQ), develop a tool aimed for measuring construction performance from a client perspective. The purpose of this paper is to describe challenges met during this development process. As the tool is under development the paper is limited to some challenges.

2. Learnings from self- assessment models

Methods for measuring excellence based on self-assessment methods have its origin in the Business Excellence (TQM) theories and practical implementations. The more modern applications started with the American Malcolm Baldrige National Quality Award (MBNQA) initiated in 1987. It has then been spread to at least 75 countries. One aspect in this diffusion process has been how valid the model is in different contexts.

The main reason for the popularity was the improvement results reported considering the financial performance, the customer satisfaction and the employee satisfaction. The toughest problem has probably been the time it consumes to go through all the criteria as it is a complex process. Five years ago, SIQ and its international sister organizations saw a declining interest in the models. One reason was related to the recession and an intensive focus on short time decisions. Another reason was that many organizations had become more mature in the TQM area.

3. Learnings from tools for measuring construction excellence

We now realize similar aims and similar interest in tools for measuring performance in construction, for example in Brazil, Chile, Denmark, UK and US. Costa et al [1] summarizes the aims of these initiatives to (a) offer guidance for performance measurement, (b) provide benchmarks that could be used by individual companies, and (c) identify and disseminate best practice. Beatham et al [2] have identified five fundamental problems in the UK KPI initiative: The focus on post-event lagging KPIs, the KPIs are not aligned to the strategy or business objectives of construction companies, it has been used more as a marketing tool than an improvement tool, the KPIs do not provide a holistic, company-wide representation of the business, and the KPIs are not incorporated into project management systems, which include review and action. Other reflections from the various tools are that few indicators measure organization, leadership and motivation, there seems to be more focus on collecting data rather than on how to use the data in relevant improvement processes, there seems to be copies from other tools that not fully consider the cultural differences and other differences, there is often a focus on contractors' activities and not on the whole project organization, including clients' and suppliers' activities.

4. Challenges met in the Swedish case

The development of the tool started with initial scanning of various aspects, for example the clients' situation in general, the clients situation in early project phases, project success factors, theoretical perspectives on performance measurement, existing systems for performance measurement in Sweden, and what the client, design and contractor companies measure. Various methods for data collection were used. During these studies we realized a number of challenges.

Defining the aim. Introductory meetings with the reference group, a group of ten experts, mainly clients, showed that the expectations on the tool were huge, but the visions varied to a great extent among the members. From their individual visions and further discussion resulted in four aims, (a) continuous improvements, especially in the on-going project, but also in the firms management system, (b) increasing efficiency, reducing time and costs, (c) making sure that all individuals are motivated and (d) controlling the process in order to increase the probability for fulfilling the project goals.

Exploring the various groups of clients. The Swedish Association for Construction Clients has a clear view on what different roles the client can have, but it is not as clear how the clients view and describe themselves. Interviews with 23 experienced clients reveiled that there are not only private and public clients but also various purposes with construction, e.g. build to lodge its own organization, build to own and let, and build to sell, aiming for maximised profit.

Deciding the prioritized characteristics. The tool for measuring performance should according to the 23 clients be simple and reliable, but also be action oriented and give fast feedback. To form a simple tool, which fulfill the expectations is never-ending challenge.

Identifying the relevant key factors. There have been numerous studies of what characterize successful construction projects (e.g. Chan and Chan, 2004). The problem is that most such studies don't consider from whose perspective, when, and for what period. In order to identify relevant key factors we summarized the findings from the initial scanning process and picked the eight factors, which were found in most reviews, and identified how they are related to each other. Lagging factors are customer satisfaction and productivity. Process factors are time, cost and project goals. Leading factors are organization, leadership and motivation., In order to put attention on positive developments, we added a ninth factor, which we call learning and development.

Designing the process of measuring in order to get a simple and reliable tool is a great challenge. The data collection is defined to be at three points, before, under and after each subproject, i.e. design, production etc. In order to improve the current project data is aimed to be reported as early as possible. For example, the organization's competence could be evaluated before start, leadership and motivation could be measured halfway. The manager for each subproject is suggested to be responsible for reporting data, except for the leading factors.

5. Conclusions

This paper considers challenges in developing tools for measuring performance within construction, especially in situations where dual aims exists. Five such challenges are briefly discussed but there are, however, many more challenges. The major one - how to perform sustainable improvements - is, for example, not really discussed here. Neither are the challenge to fit different products and different cultures, as well as the challenge to cover as much as possible of the cost mass, for example the suppliers' activities, discussed. Nor are the challenges to fit the tool to the companies' individual tools for measuring performance discussed. Most major client, design and contractor companies have tools for measuring cost, time, customer satisfaction and employee satisfaction.

6. Acknowledgements

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References

[1] Costa, D., Formoso, C., Kagioglou, M., Alarcón, L., and Lima, H. (2005) Design and Implementation of Performance Measurement Systems for Benchmarking in the Construction Industry, Proceedings of 11th Joint CIB International Symposium Combining Forces, Advancing Facilities Management and Construction through Innovation, Helsinki 13-16 June 2005

[2] Beatham, S., Anumba, C., and Thorpe, T. (2004) KPIa: a critical appraisal of their use in construction, *Benchmarking: An International Journal*, Vol. 11, No. 1, pp 93-117.

Construction competitiveness: a dynamic capabilities perspective

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The concept of dynamic capabilities focuses on the extent to which firms are able to re-configure their resources and re-modify routines in order to remain competitive in changing environments. A firm's dynamic capabilities are seen to be rooted inside its managerial processes and asset positions. They are also patterned and conditioned by the firm's historical path development. Furthermore, a firm's competitiveness depends upon the ease with which distinctive capabilities can be replicated internally by the firm itself or imitated externally by competitors. The dynamic capabilities perspective is developed as an analytical device for understanding how competitiveness is operationalised within construction firms.

Keywords: dynamic capabilities, firm competitiveness, UK construction firms

1. Changes in the UK construction industry

When attempting to understand how construction firms become and remain competitive, it is important to understand the changing context with which they operate. The UK construction industry has been influenced by a number of issues, such as 'economic and industrial factors, government policy, social and technological changes, external influences and changes which are brought about by the industry itself' [1]. In brief, construction firms need to evolve in conjunction with the broader changing environment if they are to remain competitive.

2. Current perspectives on the notion of firm competitiveness

The dynamic capabilities perspective was proposed by Teece *et al.* [2] as a broader view in comparison to three perspectives on the competitive strategy of firms. First, the competitive forces framework sees a firm's competitiveness as determined by a number of driving forces within the industry. Second, the strategic conflict approach regards a firm's competitive strategy as formed by certain expectations about how its rivals will behave. The third one is the resource-based view that emphasises firm-specific resources as the fundamental determinant of competitiveness.

3. The dynamic capabilities perspective: overview

The term 'dynamic capabilities' has two key emphases that were not prevalent in the previous literature [2]. First, the term 'dynamic' refers to 'the shifting character of the environment'. Second, the term 'capabilities' is defined as 'adapting, integrating, and reconfiguring internal and external organisational skills, resources, and functional competences toward changing environment'. In order to have a clear understanding of dynamic capabilities, it is necessary to clarify the meanings of various key terms: 'resources', 'routines', and 'competences'

3.1 Resources, routines and competences

The term 'resources' is defined as 'firm-specific assets'. These assets are difficult to imitate and transfer among firms. In contrast to the static conception of resources, a firm's capabilities are considered to be ways of assembling and organising resources to perform some task or activity. For further detail, 'routines' are the process of assembling and integrating firm-specific assets with a repetitive character. 'Competences' are related to the distinctive capabilities that enable a firm to conduct its core business.

3.2 Key features of dynamic capabilities

In an attempt to clarify the different between the dynamic capabilities perspective and the resource-based view, the value of the dynamic capabilities perspective lies in the emphasis on the process of resource reconfiguration [3]. In contrast to ordinary capabilities, dynamic capabilities focus on the repetitious process of re-modifying operational routines in dealing with change [4]. In brief, these two processes are considered as key features of dynamic capabilities.

3.3 Dynamic capabilities and sustained competitiveness

A firm's competitiveness is sustained if its dynamic capabilities are easy to replicate by the firm itself, and also difficult to imitate by its competitors. 'Replicability' and 'imitability' are two parameters for assessing a firm's dynamic capabilities [2]. Two types of strategic value can be developed from replication. One is the ability to support geographic and product line expansion; another is the ability to replicate indicates that the firm has the foundations for learning and improvement. On the other hand, the imitation performed by competitors is constrained by two factors: the easy of replication and the efficiency of intellectual property rights.

4. A dynamic capabilities framework

Building upon the three components of dynamic capabilities proposed by Teece *et al.* [2], an analytical framework for understanding the competitiveness of UK construction firms is suggested below:

4.1 Managerial and organisational Processes

Managerial and organisational processes refer to the way things are done through a firm's routines of current practice and learning. These processes include: Coordination and Integration (*e.g.* the coordination between delivery teams on site and off-site management teams, and the integration with other firms by strategic alliance); Learning (*e.g.* learning new building technologies, project delivery improvements, and market changes); Reconfiguration and Transformation (*e.g.* the responses to a client's new procurement method, the government's new policies, or emergent markets).

4.2 Asset positions

Asset positions refer to the possession of specific assets that determine a firm's competitive advantage. Examples would be: Technological Assets (*e.g.* the utilisation of specialised construction technologies provided by sub-contractors or manufacturers); Complementary Assets (*e.g.* the investment in computer equipment and trainings for the development of bespoke project management software); Reputational Assets (*e.g.* a good track record, a leading market position, an award for excellent performance, or a kitemark for achieving certain standards); Financial Assets (*e.g.* owning properties and raising cash from external markets); Structural Assets (*e.g.* a flexible organisational structure and a vertical integration with sub-contractors and suppliers); Institutional Assets (*e.g.* the pre-qualification systems or procurement rules); Market Assets (*e.g.* special types of construction works or contracting services).

4.3 Path dependencies

A construction firm's competitiveness is conditioned by its historical path development. The recognition and development of market opportunities (*e.g.* new types of contracts or works) reply on a firm's previous investments on its capacities and routines (*e.g.* specialised skill trades and production processes).

5. Conclusions

The dynamic capabilities perspective is a firm-specific analysis. It focuses on the extent to which firms are able to re-configure their resources and re-modify routines in order to remain competitive in changing environments. Its framework consisting of three key elements – managerial processes, asset positions, and path dependencies – provides an intrinsic view of how competitiveness is operationalised and sustained inside firms. In summary, it is argued that the competitiveness of construction firms relies on two key qualities. First, the capacity to understand and identify the competitive forces in play and how they change over time; second, the capabilities to re-configure resources and re-modify routines to interact with their changing business environment.

References

[1] Hillebrandt, P.M., J. Cannon, and P. Lansley (1995) *The Construction Company in and out of Recession*: Macmillian Press

[2] Teece, D.J., G. Pisano, and A. Shuen (1997) Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, 18(7): p. 509-533.

[3] Eisenhardt, K.M. and J.A.M. Martin (2000) Dynamic Capabilities: What Are They? *Strategic Management Journal*, 21(10-11): p. 1105-1121.

[4] Winter, S.G. (2003) Understanding Dynamic Capabilities. *Strategic Management Journal*, 24(10): p. 991-995.

Empirical study reveals deficits in the choice of formwork

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The choice of suitable construction techniques and methods must be made prior to construction commencing. Since a sub-optimal construction method ultimately results in sub-optimal construction processes and, in consequence, in increased costs, the choice of method should not depend on subjective criteria. Existing methods pay too little attention to uncertainties and bandwidths of the selection results and mostly do not verify the sensitivity of these results at all. In order to reduce complexity the existing methods restrict themselves on partial processes. As a consequence it is impossible to gain a holistic point of view. To overcome these limitations of the selection process an internationally-active formwork manufacturer and a big Swiss construction company interacted with the Institute for Construction Engineering and Management at ETH Zurich to develop a cybernetic, process-based and system-oriented decision model for the selection of formwork. To identify the initial position as well as the practical demands on the anticipated decision model an empirical study was conducted. This paper presents the results of the empirical study and the deficits associated with the state of the art of formwork selection.

Keywords: choice of formwork, integrated, project-specific, process-based.

1. Introduction

Due to the basic conditions of the Swiss construction market construction companies are forced more than ever to execute their projects as economically and efficiently as possible in order to strengthen their competitiveness and assure their survival in the market economy [1]. This is only possible if they strive for operational excellence respectively best-practice in the individual processes, for which systematic selection processes for the construction methods are required. Since formwork costs form an important part of costs of reinforced concrete works, the project-specific optimal formwork system has a significant relevance on the overall project result.

Since no company can afford sub-optimal construction methods, a research project was initiated by the Institute for Construction Management and Economics at ETH Zurich to develop a cybernetic, process-based and system-oriented decision model for the selection of formwork that incorporates interactive and interface-relevant influences caused by parallel processes. To identify the initial position as well as the practical demands on the model, an empirical study was conducted in regard to the selection criteria for the decision making model.

2. Research methodology

To analyze the state of practice, a combination of epistemological methods will be applied to obtain research results using qualitative social research and quantitative investigations [2, 3]. Therefore an research plan including general epistemological questions and an interview guideline was constructed. The hermeneutical spiral for this research project combined systematic literature research to achieve basic knowledge about selection criteria and interviews focusing on the building construction sector in German-speaking countries. The qualitative research was conducted by semi-structured and problem-oriented interviews. In the context of the quantitative research the interview partner were asked to weight the different selection criteria that were determined during the qualitative as well as the literature research. To secure the generalizability of the research results, the interview partners were chosen by strictly adopting the rules of qualitative sampling [4].

3. Findings from the study

The investigation needed to take into account the fact that the interviews were conducted both with a formwork manufacturer as supplier and construction companies as its customers. These players pursue differing economic goals – customers want to minimize overall costs, suppliers want to maximize sales – which is why they had to be evaluated separately. In addition, the study revealed the extent to which the supplier recognizes the customers' goals and can generate maximum customer benefit in order to increase market shares and maximize profits. Based on a controlled methodically analysis four categories could be identified:

3.1 Systematics

Neither the interviewees of the supplier nor the ones of the customers adopt a cross-corporate standard systematic approach to selecting formwork systems. In addition to that only about 40% of the overall interviewees were able to describe a clear structure of the individual work steps and their sequence. Therefore it can be stated that not even the decision-finding processes of the individual engineers are based on a clear structure.

3.2 Subjectivity

It was found that all interviewees – both on side of the supplier as well as on side of the customers – base their decision-making process on personal experience and personal preferences. However only one third of them is aware that their intuitive handling prevents them from examining other, possibly better solutions.

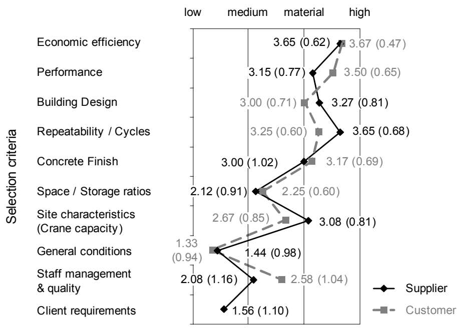

Figure 1. Comparison of selection criteria and their importance with indication of the mean values (standard deviation)

The prioritization of the selection criteria varies from one agent to the next as can be read off the large standard deviation of the single criteria (Fig. 1). As such, the reproducibility of decisions is not given.

The high correlation of the mean values for supplier and customers shows, that the various criteria are weighted similarly by both sides, apart from a few exceptions like staff management and quality (Fig. 1). Therefore it can be stated, that the supplier recognizes the customers' goals and incorporates them already in his decision-making process.

In a second analysis the collected data was analysed regarding the various functional levels separately for supplier and customers. The weighting of the different selection criteria turned out to be more or less independent of the functional level on the part of the supplier, whereas the findings revealed marked differences in the weighting on the part of the customers.

Further selection criteria were listed and classified as relevant by the interview partners during the collection of qualitative data; on customer side, it were the flexibility of the formwork system and the foreman's preferences, the interview partners on supplier side listed the material availability, personal contacts and a basis of trust.

3.3 Inclusion of interfaces

Nearly 80% of the interviewees admitted to taking no or scarcely any internal (e.g. concrete works) and external (e.g. concrete versus finishing works) interfaces in account when selecting a formwork system. Since these interfaces often cause non value adding activities they reduce the project profitability and will therefore be considered in the anticipated decision model for the selection of formwork.

3.4 Inclusion of uncertainties

In practice there are generally two ways of dealing with uncertainties: The aspect of uncertainties is totally ignored or unrelated buffer times and defensive performance assumptions are used. Neither of the two alternatives seems to be ideal for guaranteeing economical and low-friction construction works.

4. Conclusion

Based on the evaluation of the qualitative and quantitative data collected, the study was able to prove that, generally speaking, neither theoretically existing knowledge nor a (standard) systematic approach are applied, nor are the internal and external interfaces taken into account when it comes to choosing systems. The study further revealed that any investigation of economic efficiency to date has been restricted to an analysis of the requisite stock volumes and the costs immediately associated with the formwork. Since no signs of a holistic approach were found in practice, the next steps will be to incorporate the associated internal and external interfaces and to integrate the technical and economic impacts of formwork system decisions on the overall process into the decision making process.

References

[1] Girmscheid, G. (2005) *Angebots- und Ausführungsmanagement - Leitfaden für Bauunternehmen,* Berlin, Springer Verlag.

[2] Girmscheid, G. (2004) *Forschungsmethodik in den Baubetriebswissenschaften,* Zürich, Eigenverlag des IBB an der ETH Zürich.

[3] Walker, D. H. T. (1997) Choosing an appropriate research methodology. *Construction Management & Economics,* 15**,** 149.

[4] Yin, R. K. (2003) *Case study research design and methods,* Thousand Oaks, Sage Publications.

Factor-specific approach to customer satisfaction with construction

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Customer satisfaction and performance measurement have gained considerable attention amongst both academics and practitioners in the last few years. In fact, customer satisfaction has become an essential part of KPIs (key performance indicators) in the construction industry. This paper examines customer satisfaction through factor analysis. The purpose of this paper is to explore empirically contractor's performance as perceived by customers. The survey data were gathered from 831 respondents. Factor analysis was used to categorize different variables into reasonable groups. More specifically, the following research questions will be explored: In which groups different variables could be classified? How do customer perceptions of the contractors' performance differ between the branches of construction industry? The result of the analysis indicates that significant differences are apparent in the performance between the branches of the industry. Factor analysis shows that customer satisfaction indicators could be divided into different subgroups of variables with consistent real life interpretation.

Keywords: Performance measurement, customer satisfaction, construction, factor analysis, analysis of variance

1. Customer satisfaction with the construction

Customer satisfaction has become an essential part of performance criteria in construction [1]. Traditionally, success in construction is measured through the iron triangle: budget, quality and costs. Increasingly, construction companies have adopted a TQM philosophy in their quality improvement efforts. In construction, poor quality leads to rework, which has considerable implications on cost and schedule. In addition, the complex nature of the construction process, changes in project organisation, and the uniqueness of each project make it difficult to exploit past experiences and customer feedback in the future. It is stated that construction companies do not actively collect customer feedback as they can seldom expect to receive honest and sincere input For that reason, contractors tend to focus on their own business within the terms of the contract [2]. It has been found that in the construction, TQM has to be applied to the whole supply chain since the overall performance is a function of the performance of each participant. Therefore, the key participants need to assess each others' performance on a regular basis in order to continuously seek improvements in their own performance for the benefit of the overall project [3]. However, the performance of a contractor has significant implications on the quality perceived by the customer. It has been widely stated in construction that the customers' satisfaction will be affected by both the quality of service delivery and quality of constructed facility. Customer satisfaction in construction could be determined by the extent to which the completed facility meets or exceeds the customer's expectations. The customer's expectations of construction are a function of several factors: the customer's past or direct experiences with the contractor and similar contractors, word of mouth about the contractor, and the customer's personal needs. If customers are fully satisfied, they are willing to engage the same contractor to conduct afterwards works. Therefore, satisfaction reflects customers' experiences of and confidence in the contractors' abilities and co-operation. A dissatisfied customer will not work with that contractor in the future but a satisfied customer would not necessarily guarantee future projects to the contractor. Therefore, the main benefit of high customer satisfaction for a contractor is the opportunity to remain the customer's potential partner in the future.

2. The study

The data for this study were generated as a function of the Construction Quality Association (RALA). In practice, the customer (owner or, in case of subcontracts, general contractor) fills in a form at the time of conclusion of a project and delivers it to RALA immediately following the completion of the project. Feedback from the projects was collected using a 22-item. The respondents gave their responses regarding their level of satisfaction on a five-point interval scale from 1 (indicating very high dissatisfaction) to 5 (indicating very high satisfaction) for all the items.

3. Essential factors in CS

Every observed variable in data can be interesting. However, the variables in data are often correlated. This means that observed variables measure at least to some degree same thing(s). We tried to find out what these common factors are and study how to measure these factors. One of the most easily interpretable solution is presented in Table 2. Maximum likelihood was used in estimation and component loss criterion in rotation [4].

Table 1. Result of ANOVA for the hypothesis that all variable means are the same

Variable	Size	Mean	Variance
A1	831	3.63	0.774
A3	831	3.38	0.889
A6	831	3.92	0.926
A14	831	3.39	0.772
A18	831	3.46	0.983
	Anova table		
Source	DF	SS	F-value
Treatment	4	170.95	49.133
Error	4150	3609.86	
Total	4154	3780.82	
Classical F-Test;			
p-value under the equal variance assumption: 0			
Generalized F-Test;			
p-value without the equal variance assumption: 0			

Next, a one-way analysis of variance (ANOVA) is used to compare the manner in which five main manifest variables (the largest loadings on the five factors) differ from each other in an average level. The test results for the hypothesis that the variable means do not differ between any variables are presented in Table 1. We found that there exist differences in means of the most essential indicator variables. Finally, we examined the differences in the project type and project nature according to the constructed factors. The result was that there are differences.

4. Conclusions

The factor structure described is simple and rather easy to interpret. This can suggest changes to theory of customer satisfaction.

The test results for the hypothesis that variable means do not differ between any variables were rejected

Capacity of supplier's personnel for co-operation has larger a mean than any other variable. Correspondingly, variables Management and implementation of agreed quality assurance procedures and Management of environmental issues and related know-how on site were at the lowest level by means. Industrial project seems to have the largest means by all factors, and residential renovation had the lowest level of differences when examining by project type and project.

Table 2. Rotated factor matrix

	Variables	Factor loading
F1	Skill of supplier's workers	1.007
F1	Commitment of supplier's employees to set goals	0.505
F2	Management and implementation of agreed quality assurance procedures	0.483
F2	Conformity of supplier's subcontracting to contract	0.425
F2	Quality of assignment material and maintenance manual	0.393
F3	Capacity of supplier's personnel for co-operation	0.838
F3	Agreement on changes	0.646
F3	Access of supplier's employees	0.622
F3	Quality of overall service level	0.611
F3	Information flow on site	0.526
F3	Skill of supplier's work supervisors	0.447
F3	Tending to notices of defects	0.426
F3	Tending to site supervision duties	0.403
F4	Management of environmental issues and related know-how on site	0.765
F4	Management of work safety on site	0.704
F4	Cleanliness and order on site	0.547
F4	Tending to official obligations	0.278
F4	Degree of completion at handover inspection	1.010
F5	Repair of defects and deficiencies noticed during handover inspection	0.512
F5	Workability of handover material and maintenance manual	0.480
F5	Adherence to schedule in accordance with common agreements	0.474
F5	Contracted work quality	0.312
	Factors rotated according to CLC	

References

[1] Chan, A.P.C. and Chan, A.P.L. (2004). Key performance indicators for measuring construction success. Benchmarking: An International Journal. Vol. 11 No. 2, pp.203-221.
[2] Ahmad, S.M. and Kangari, R. (1995). Analysis of Client-Satisfaction Factors in Construction Industry. Journal of Management in Engineering.
[3] Soetanto, R., Proverbs, DG. and Holt G.D. (2001). Achieving quality construction projects based on harmonious working relationships. Clients´ and architects´ perceptions of contractor performance. International Journal of Quality & Reliability Management. Vol.18 No.5, pp. 528-548.
[4] Jennrich, R.I. (2004). Rotation to simple loadings using component loss functions: The orthogonal case. Psychometrika, 69, 257-2

Construction managers in the 21st century

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Managers run companies and projects with the purpose of achieving maximum business results through the direct control of labour performance and the flow of considerable financial resources. Thus educating civil engineers to manage companies and projects successfully is an extremely important task for the development of not only construction industry but country's economy as well. Management for engineers is a form of additional education, because it provides knowledge and skills that enable engineers to master business processes more easily, and to adapt to globalisation processes more quickly and painlessly. Analysing management curricula from best universities and schools and comparing the "knowledge offer" with professionals "knowledge needs" in companies, using questionnaires and field research tools, we have produced an MBA in Construction program at the University of Zagreb. The content, the programme and some dilemmas are presented in this paper.

Keywords: civil engineering, education, MBA.

1. Introduction

MBA started its life as an "elite" business qualification for potential leaders and senior managers. The title "Master of Business Administration" stems from times when senior management practice was concerned with administration. It started out as an American, then Anglo-American, qualification and in the 1960s it was adopted in Europe. MBA programmes and curricula have developed along "capitalist" market principles and represent a Western interpretation of management and leadership. All MBA courses, according to Kempner (as cited in Kretovics [1]), have the same objectives: "to develop managers who will run efficient, profitable enterprises in a competitive world for the creation of wealth in society". One may wonder if there is any sense in starting another MBA at the University that, in spite of its history of university education since 1669, is not a "prestigious" business school from the UK or the USA. To paraphrase Kathawala *et al.* [2], "should we have a dilemma? Are we really doing students a disservice by even offering them an MBA? Is MBA a global qualification? Does one size fit all?" But for us there were no dilemmas at all. The aims of MBA programmes are very clear - to prepare their graduates for managerial roles, help them gain a better understanding of the industrial and business world and its needs, enrich their skills and provide them with competences relevant to their careers.

2. MBA? yes or no?

Today MBA is allegedly a global qualification, taught all around the world and also delivered by e-learning, so it is globally accessible. MBA courses and their methods of delivery now differ enormously. There are one-year and two-year degrees, full-time and part-time degrees, campus-based versus distance learning MBAs, "consortium MBAs" with foundation companies, single company programmes and others, including action learning approaches [3]. Birchall and Smith [4] view the MBA market as having considerable potential for a diverse range of business school offerings. Should MBA be offered with specialisations, for example, to address certain niche markets (e.g. an MBA in Health Sector Management, or an MBA in Marketing), or should it remain focussed on a generalised, all-round curriculum supposedly applicable to everyone? At the moment, none of the answers to these questions are clear as conflicting views are held both within and between institutions, and for and against the MBAs Specialisation in MBA is today probably the most highly respected qualification in business in new – former Eastern European countries, as it is perceived as a form of additional high education in management. To understand such an attitude one has to know that former political and economic systems where based on centralised economy, meaning that all major business decisions were politically and not economically grounded. Thus the need for "western style" business education is so huge and MBAs are expanding.

3. Why MBA in construction

When it comes to the construction industry, the MBA programmes offering "general managerial training" have to be modified, as they are not entirely appropriate for the needs of construction managers. Construction differs fundamentally from all other industries, because in a "normal" industry the product changes its place and the production factors (people and machinery) are static. In construction it is the opposite –

the product (the site, the building under construction) is static and does not change its place. When the "production process" is finished "the product" stays where it was made, while the production factors (people and machinery) move on to the next location – to the "next product". The demand for multidisciplinary and interdisciplinary programmes is progressively increasing. International "MBA in Construction" given at the University of Zagreb is a programme that focuses on construction with the purpose of providing present and future construction managers with knowledge in various fields necessary for understanding and mastering complex management processes. Educating civil engineers to manage successfully, as proposed in our International "MBA in Construction" programme, is probably a crucial and extremely important task not only for Croatia's economic development, but for the region as well.

4. The program

In his recent critique of MBAs, Mintzberg (as cited in Beech [5]) argues that there are four aspects in which an MBA programme can be international: the students; the staff; the location and locus of control; and the context, philosophy and culture. He goes on to say that on the basis of using these aspects of internationalism as criteria, he knows of no international MBA programmes. Although we are aware that MBA in Construction delivered by the University of Zagreb and its partners is not meeting these requirements entirely, it was a kind of a challenge for us to evaluate our program according to Mintzberg. The results are presented in the paper.

5. What should we do to improve further?

Bearing in mind the very rapid changes in research and the need to fundamentally change the approach to lifelong education and upgrading, especially in interdisciplinary and multidisciplinary fields, the use of the new e-learning technologies for knowledge transfer by trained highly-qualified professional teachers is becoming a possible solution for the quality lifelong education of constructors, in harmony with European and world trends. Comparing e-learning MBAs and traditional MBAs with regard to their global potential, the strengths are that it can be disseminated to large numbers globally, affording local delivery where students cannot attend class, and allowing people to receive high education without having to be out of work for a long time. Thus we are working on introducing e-learning methods to our next International "MBA in Construction" generation of students.

6. Conclusions

Many countries in our part of the world require great investments in construction and modernisation of the infrastructure and other facilities to advance the potentials necessary for economic and political stability and development. This can only be achieved with well-trained managers who are experienced in construction. Therefore, the "MBA in Construction" is designed to appeal to managers within all construction disciplines. The need for a different and more flexible approach to learning is especially shown after the completion of regular education. Technologies and knowledge change very quickly, and the world is becoming a "global village" where information is exchanged in real time. This is especially so in engineering professions such as construction. Croatia has become part of the European market and there is a need for the additional education of civil engineers, especially in business management, which also includes project management. If Croatia is to enter the global knowledge society we must educate the best engineers and provide them with new knowledge, competencies and skills.

References:

[1] Kretovics, M. (1999), *Assessing the MBA, What do our students learn?* The Journal of Management Development, Vol.18 No.2, 1999, pp.125-136

[2] Kathawala, Y., Abdou, K., Elmuti, D.S. (2002), *"The global MBA: a comparative assessment for its future"*, Journal of European Industrial Training, Vol. 26 No.1, pp.14-23.

[3] Nicholls J.,Harris J., Morgan E., Clarke K.,Sims D.: *Marketing higher education: the MBA experience*, Inter. Jour.of Educ. Management,Vol.9No.2,pp.31-38

[4] Birchall, D., Smith, M. (2002), *Scope and Scale of E-learning Delivery amongst UK Business Schools*, CEML, London.

[5] Beech, N.(2006*), Intense, vigorous, soft and fun: identity work and the international MBA*, Critical perspective on international business, Vol.2 No.1, 2006, pp.41-57

EURASIA: Built and human environment research collaboration between Europe and Asia

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The EURASIA project is an international collaborative research project which aims to enhance the capacity of the partner institutions for training, teaching and research activities required for the creation and long-term management of public and commercial facilities and infrastructure. Through this paper the academic rigor of this research project is expected to be improved through opening the concept to a rich discussion and to a peer review process. Based on that intention the rationale behind the project, its aims and objectives and expected benefits are presented.

Keywords: Capacity Building, Post Tsunami Rehabilitation, Facilities and Infrastructure Management, Curriculum Development

1. The EURASIA project

The post tsunami rehabilitation in Sri Lanka demands creation and long-term management of infrastructure and facilities of both public and commercial sectors. If this demand is to be addressed, it primarily requires appropriate teaching, training and research activities to be established within the areas affected. However, it has been identified that higher education institutes within Sri Lanka do not have the required capacity to cater for this teaching, training and research demand specifically at the postgraduate and industry level. It has also identified that the required capacity is culturally sensitive and location and economy dependent, making it inappropriate to employ direct foreign knowledge on this matter. Thus the European and Asian Infrastructure Advantage (EURASIA) research project is initiated to locally build the required capacity for the above purpose by means of collaborating between European and Asian partner institutes. At the same time it is anticipated that this mutual collaboration will enhance the European partner capacities in terms of their teaching, training and research activities perspectives within the built and human environment concerns. This is planned to be achieved through sharing good practices beyond the cultural and economical barriers, where both the Asian and European partners will be benefited equally.

2. Project aims and objectives

Governed by the issues and the requirements highlighted above, this project aims to enhance the capacity of the partner institutions for training, teaching and research activities required for the creation and long-term management of public and commercial facilities and infrastructure. It will target (direct) postgraduate students, and junior and senior faculty members from the EU and Sri Lankan partner institutions and (indirect) researchers, other public sector organisations, consultancies and industry. The project objectives are of two folds; the overall objectives and the specific objectives.

The overall objective of the project is to foster cooperation in Higher Education institutions in both Europe and Asia, improve reciprocal understanding of cultures, exchange best practice and strengthen mutual awareness of study programmes. The project will achieve this through management of public and commercial facilities and elements of infrastructure (this is referred as FM in this project). The specific objective of the project is to enhance the capacity of the partner institutions for training, teaching and research activities required for the creation and long-term management of public and commercial facilities and elements of infrastructure associated with post-Tsunami activities in Sri Lanka. It will target postgraduate students, and junior and senior faculty members from the EU and Sri Lankan partner institutions. It will target postgraduate students, and junior and senior faculty members from the EU and Sri Lankan partner institutions, emphasising Asia link programme's objective to provide a framework for activities aimed towards promoting mutual awareness and understanding, exchanges and economics co-operation between the two regions using uses HE sector to promote EU-Asia relations.

3. Methodology

The methodology of this project is based on seven work packages (WP). The objectives of each work package can be highlighted as follows;

WP1 – Project Management and Evaluation - manages partner roles, coordinates the delivery of project outcomes and, develops and manages infrastructure to: Establish working procedures and reporting structures, Provide management time, administration, coordination functions, organise the Steering Committee, progress reports and maintain all records of expenditure, Manage work package activities and deliverables against agreed milestones, and Submit a final report to the funding body and relevant agencies

WP 2 – Curriculum Assessment, Systems and Procedures - manages the development of a joint curriculum at postgraduate level, and joint institutional systems and procedures, for the provision and monitoring of training, teaching and research activities, associated with the creation and long term management of public and commercial facilities and elements of infrastructure

WP 3 - Module Development - manages the development of a structured database of world-class teaching materials in support of a curriculum on the creation and long term management of public and commercial facilities and elements of infrastructure

WP 4 - Split Site PhD Coordination - manages a split-site PhD programme to develop long term human resource capacity in the two Sri Lankan Higher Education Institutes to carry forward the joint curriculum and to provide career development opportunities for Sri Lankan Higher Education junior faculty members to follow postgraduate level study in partner Institutes

WP 5 - Training Programme - manages the development and delivery of a training programme on the creation and long term management of public and commercial facilities and elements of infrastructure to develop capacity in the Sri Lankan and EU Higher Education Institutes to carry forward the joint curriculum and to enhance the skills of educators involved in the delivery of the joint curriculum

WP 6 - Staff Exchange Coordination - manages academic staff exchanges to provide external perspective in developing a joint curriculum into the creation and long term management of public and commercial facilities and elements of infrastructure and improve the mobility of teaching and research staff at partner Institutions etc.

WP 7 – Dissemination - manages the dissemination of findings to communicate the results of the project, including the joint curriculum, research findings, exemplar strategies and practices.

4. Expected benefits

The benefits of the project can be identified with related to the target groups. Those are; Policy makers and the governments: Specifically this project will help the Sri Lankan government towards the post tsunami rehabilitation through enhancing the capacities of policy making and other related organisations. Teaching and administrative staff: Staff will benefit from exposure to cross cultural teaching activities through the engagement in the exchange of experience and expertise to conduct teaching and training. Postgraduate students: PG students will benefit through enhancing the knowledge and skills of postgraduate students in facilities and infrastructure management by means of combining and sharing resources in a network of five strategically chosen universities within EU and Asia (Sri Lanka). Researchers: an estimated 160 researchers across the partner network will gain access to facilities and infrastructure management principles and its latest developments particularly within an Asian context via the partners. HE institutions: project will allow EU institutions to improve human capacity development associated with the current status of FM knowledge bases with updates relating to the elements relating to Asia, business continuity management in particular.

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6. References and bibliography

[1] BBC (2005) [online]. [Date accessed: 20th February 2006]. Available from World Wide Web:http://news.bbc.co.uk/1/hi/world/asia-pacific/4126019.stm

[2] UNEP (2005) Natural Rapid Environmental Assessment – Sri Lanka, UNEP Sri Lanka Country Report – 2005

ICT for construction process improvement Enabler or a driver?

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Process improvement has been identified as a mechanism of achieving the much needed performance improvements within the construction industry. Despite the concerns of being an industry with unique characteristics, construction has borrowed some process improvement principles from other industries such as software. However, while ICT has been treated as an important asset for process improvements in other industries, construction has demonstrated a slow ICT uptake. This slow ICT uptake initiated the discussion about the position of the ICT within the process improvement initiatives as an enabler or a driver. This paper investigates this phenomenon through a comprehensive literature review and four pilot interviews with ICT exterpts in the construction industry and academia.

Keywords: Construction process improvement, ICT in Construction, Process – IT co-maturation

1. UK construction and process improvement

Process improvement has been identified as a mechanism of achieving the desired process improvements within the construction industry. While a complete evolutionary approach doesn't cater for the dramatic improvement needs of construction as highlighted by Latham [1], the direct application of revolutionary approaches such as Business Process Re engineering (BPR) within the industry has also been criticised by the researchers due to unique characteristics of construction. Taking this fact in to consideration, Sarshar et al [2] have initiated a capability maturity model (CMM) based approach in construction process improvement. CMM is based on a five levelled structure. Within this, organisations are ranged from level 1 to level 5 based on their maturity. Within this framework, a maturity level has been defined as "a well defined evolutionary plateau towards achieving mature processes. Level 1 organisations are the least matured organisations where as level 5 organisations are the most matured organisations. Sarshar et al [2] have attempted to apply the principles of this model within the construction industry under the name SPICE. This research was carried out in stages, and currently, the dynamics up to the level 3 of the CMM were explored and customised to the UK construction industry. Up to date research status of the SPICE project shows clear gaps in identification of the characteristics of higher maturity levels. Addressing the identified gap Keraminiyage et at [3] have presented a conceptual framework for the construction higher capability maturity level dynamics. Within this conceptual framework, five key process areas (KPAs) have been identified as key steps towards achieving higher capability maturity. Those are; 1. Quantitative process management in construction 2. Construction product quality management 3. Quantitative Defect Management in Construction 4. Construction Defect Prevention 5. Construction Process Change Management. More details and the rationale behind this KPAs can be found in [3].

2. Role of ICT in construction process improvement

Despite the fact the ICT plays a major role in process improvement initiatives, the construction industry has been criticised for its slow ICT adoptability. Further more; the industry has become frustrated with the falling of ICT as many companies have invested in the wrong technologies without addressing the business needs. This suggests that, proper processes have to be in place in order to harness the actual benefits of the ICT capabilities within construction organisations making ICT an enabler. On the other hand, ICT has created a significant impact on some of the work patterns and processes within organisations As an example, with the introduction of computer based drafting tools such as AutoCAD the traditional drawing boards are becoming redundant rapidly. This exemplifies the fact that, irrespective of processes in place, ICT has influenced organisations to change their work patters and processes acting as a driver for the construction process improvements. Above discussion highlights the fact that ICT applications and process change within the construction industry are co-dependent. To investigate this phenomenon furher, the authors have conducted a series of pilot interviews (four) to identify the actual stand of the ICT usage in construction and the required level of ICT uptake towards process improvements. For the purpose of these interviews, the higher capability maturity dynamics of construction process improvement [3] have been taken as the basis and the level of ICT uptake is discussed within a scale of being an enabler to a driver.

3. Pilot interview outcomes

Current stand of ICT within the construction industry: The current level of ICT uptake within the construction industry is largely limited to the automation of existing processes, and very little attempts have been made, if any, to use ICT at strategic level to improve processes. it is also visible that, in general the current ICT uptake within the construction industry appears to be a driver for process changes, but not necessarily those changes reflect improvements. ICT for Quantitative Process management in Construction: All the interviewees felt that ICT can / should be a driver for this KPA as there are generic ICT tools available such as Microsoft Project or Primavera which has the potential to achieve what is expected from this key process area. However, if ICT could have been a driver for this, mere availability of such tools would have driven the industry towards improving or introducing their processes, where as there is no clear evidence to that effect. Construction product quality management: Within this context, the ICT has been identified as an indirect driver for change within the construction industry. More specifically, the availability of software tools to measure the parameters such as energy efficiency have enabled the introduction of new building regulations, and intern these regulations acted as drivers for macro level construction process improvements. Quantitative Defect Management in Construction: Thinking outside the frame of construction, there are some readily available software tools to track defects under different scenarios. As an example, one interviewee has mentioned about "Bugzila"; a software tools which is being used in the software industry to track software bugs, as having the potential to cater for quantitative defect management in construction. Moreover, stating from simple spreadsheet packages to more complicated statistical analysis packages can be used as potential ICT tools when addressing Quantitative Defect Management requirements in construction. This clearly shows that the current ICT has the capability act as an enabler within the construction industry to achieve quantitative defect management. Construction Defect Prevention: All the interviewees felt that this area is still under research within the ICT domain as the ICT to help this sort of activities can fall under the categorisation of "Intelligent computing". As such it is hard to define the effect of such tools within the scale from an enabler to a driver. However, one of the interviewees has also mentioned that "it is beyond the capabilities of the construction industry within a foreseeable future considering the current ICT uptake". Construction Process Change Management: The role of ICT within this aspect has been identified by most of the interviewees as an enabler. Specifically, most of the interviewees addressed the need of modelling the existing processes as a prerequisite to this KPA and highlighted the fact that there are number of options available to perform that task using modern ICT tools.

4. Conclusion and the way forward

From the above it is visible that even though that the current ICT usage within the construction is more of a driver for process changes, considering the higher capability maturity level KPAs, it is noticeable that the actual role of ICT should be of the nature of an enabler. Further, when it comes to higher capability maturity levels, it may well be the case that the modern ICT may not fully capable of providing the expected level of support for construction process improvements either as an enabler or a driver. This is a part of an ongoing PhD, it is intended to validate this initial understanding about the higher capability maturity dynamics and the process – IT co maturation through a case study approach. Further, this model is intended to go through several refinement cycles to ensure that it captures the actual industry characteristics and requirements.

5. References

[1] Latham, M. (1994), Constructing the Team, HMSO

[2] Sarshar, M. Haigh, R. Finnemore, M. Aouad, G. Barrett, P. Baldry, D. and Sexton, M. (2000) SPICE: A Business Process Diagnostics Tool for Construction Projects. Engineering Construction & Architectural Management, 7(3), pp. 241-250. [19]

[3]Keraminiyage, K.P. Amaratunga, D. and Haigh, R., (2006), Higher capability maturity dynamics of UK construction organisations, 6th International Postgraduate Conference, 3-7 April, Salford, UK

Theory of production - bridge between construction economics and construction management?

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In production management, there are at least three commonly used, but mostly implicit theories of production: transformation theory of production, flow theory of production and value generation theory of production. Comparison reveals that the economical theory of production broadly equates to the transformation theory of production, as used in production management. In production management, the transformation theory of production has been the underpinning of the mainstream thinking in the major part of the 20th century. It is only in the last decades of that century that the two other theories have started to challenge the transformation theory. However, today, the transformation theory is in many production management circles rejected as the sole theory of production. This is causing a theoretical rift between economics and production management. It is suggested that also economics should critically assess its prevailing theory of production, and adopt more valid theories.

Keywords: production, construction management, construction economics, theory

1. Introduction

All built environment (as well as all the artifacts we are daily using in the framework of it) exists because it has been produced. It is the ability to produce that distinguishes between the rich and the poor nation. It is the ability to produce in a sustainable way that seems to determine the fate of mankind. Without debate, production is of central significance for human societies. However, this invites the question: What do we know about production? Given that sciences tend to present their most fundamental knowledge in the form of theories: Which is our theory of production?

Production has been especially focused on by two disciplines: economics and production/operations management, both of which contain a sub-discipline for considering those situations occurring in the context of construction: construction economics and construction management. These two sub-disciplines are closely allied, and thus also the compatibility of their theories of production seems, at first sight, of importance. However, taking into account that these two sub-disciplines practically viewed inherit their theories from their mother disciplines, the focus here is mostly on the latter, i.e. economics and operations management.

2. Production theory in economics

There is hardly a better starting point for investigation of the doctrine of economics than the well known text book by Samuelson and Nordhaus [1]. According to it, "The theory of production" is about the maximum amount of output that can be produced with a given amount of factor inputs. The technical law relating inputs to outputs is called production function. In fact, the theory of production is not treated in the textbook of Samuelson due to the intrinsic interest of production, but rather "as a prelude to our general discussion of distribution of income". This is not a different position given to the theory of production in comparison to a classical economist who contributed to the establishment of the production theory, Walras [2].

Frisch [3] clarifies the economic angle to production in a useful way: "By production in the economic sense we mean the attempt to create a product which is more highly valued than the original input elements." An initiative towards an alternative production theory is provided by Georgescu-Roegen [4]. He contends that the momentary view on production is wrong at the outset, and proposes a new form of production function that describes production over its duration.

3. Production theory in production/operations management

During the last century, production has mostly been conceptualized as a transformation of inputs to outputs. There are a number of principles, by means of which production is managed. These principles suggest, for example, decomposing the total transformation hierarchically into smaller transformations, or tasks, and minimizing the cost of each task independently.

However, this foundation of production is an idealization, and in complex production settings the associated idealization error becomes unacceptably large. There are two main deficiencies: it is not recognized that there are also other phenomena in production besides transformations (called waste in operations management), and it is not recognized that it is not the transformation itself that makes the output valuable, but that the output conforms to the customer's requirements.

There has existed, since the 1920s, another concept of production, namely the view of production as flow. Currently, the flow view is embodied in lean production. This concept views production as a flow, where, in addition to transformation, there are waiting, inspection and moving stages. Queueing theory, which applies to such flows, teaches that variability is the crucial determinant of the behavior of flows. Production management equates to minimizing the share of non-transformation stages of the production flow, especially by reducing variability.

Yet a third view on production has existed since the 1930s. In the value generation view, the basic thrust is to reach the best possible value from the point of view of the customer. Especially the quality movement has endeavored to translate this view into methods and practices useful in the industry. Principles related to rigorous requirement analysis and systematized flowdown of requirements, for example, are put forward.

Thus, there are three major theories of production in operations management, and each of them has produced practical methods, tools and production templates [5].

4. Discussion

It is easy to note that the idea of production as transformation is shared by economics and operations management. In both cases, the transformation is characterized through its inputs and outputs. However, the use of this conceptualization is slightly different. In economics, the main interest is towards finding the optimal set of inputs, whereas in operations management, the goal is much wider, to discover what must be done and which inputs are needed. Surely, the economic aspect is included in the operations management concept of transformations.

Thus, superficially, we have a cozy co-existence of two disciplines, sharing a fundamental conceptualization that seemingly provides a bridge between these disciplines. However, the transformation theory is only one of the three theories of production used in operations management. Let us recall that the main benefit of the flow theory is related to the explanation of the formation of costs, while the value generation theory contributes to the explanation of how value is formed. In the logic of operations management, the transformation theory is not capable of adequately explaining cost or value.

Now, the serious and troublesome question arises: Is the economic theory of production capable of explaining the formation cost and value in the production process? After all, according to Frisch, the economic viewpoint to production is how to achieve a product which is more highly valued than the original input elements, and thus the explanation of both costs (of the input elements) and value (of the product) is a central task for economics.

Careful consideration reveals the inevitable answer: no. The production theory, supported by the idea of input-output-transformation is fundamentally limited by its conceptualization, and does not catch the major phenomena that play a role in the formation of costs and value.

5. Conclusions

It is suggested that economics should critically assess its prevailing theory of production, and adopt more valid theories.

References

[1] Samuelson, Paul A. & Nordhaus, William D. (1985) Economics. Twelfth Edition. McGraw-Hill Book Company, New York.

[2] Walras, Léon. (1952) Éléments d'économie politique pure ou théorie de la richesse sociale. Édition définitive. R. Pichon et R. Durand-Auzias, Paris.

[3] Frisch, Ragnar (1965) Theory of production. D. Reidel, Dordrecht. 370 p.

[4] Georgescu-Roegen, N. (1970) The Economics of Production. The American Economic Review, Vol. 60, No. 2, pp. 1 - 9.

[5] Koskela, Lauri (2000) An exploration towards a production theory and its application to construction. VTT Publications 408. Espoo

What is Lean Construction – 2006

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The paper tries to characterize the work carried out in the framework of the International Group for Lean Construction by focusing on the interface of theory and practice in the research and development of production control for construction. The origin, evolution, diffusion and impacts of the Last Planner system of production control are reviewed. Then, the theoretical underpinnings of both conventional production control and the Last Planner are presented and mutually contrasted. It is argued that theories can be used for explaining the shortcomings of the conventional way of production control, as well as for stimulating or explaining new methods and tools. It is contended that lean construction is a scientific-industrial movement, inspired by the Toyota Production System, aiming at renewing the fundamentals of production management in construction.

Keywords: lean construction, construction management, theory, implementation, Last Planner, production control.

1. Introduction

The paper tries to characterize the work carried out in the framework of the International Group for Lean Construction (IGLC). Instead of an extensive approach, trying to widely cover theoretical, empirical and methodical gains, this paper adopts an intensive approach, where a salient topic is deeply sounded in the hope of generalizable insights. Thus, we focus on the interface of theory and practice in the research and development of production control for construction. This topic was the foremost at the time of the establishment of IGLC, and even if the spectrum of topics has considerably widened, still remains a core issue for this research community.

2. Practice of lean production control: Last planner

The impetus for development of the Last Planner [1] was a discovery, in the early 90's, that weekly work plans of both engineering teams and construction crews routinely had less than 60% of planned tasks completed at week's end. The researchers came to see a daily or weekly work plan as a prediction of a future state of the project. Their first concern was with the impact on the productivity of the engineering team or construction crew itself of poor predictability.

The Last Planner system was developed piecemeal, in response to the discovery of additional functions needed in order to manage this problem of work flow variability. Quality criteria for assignments were first developed, driven by the hypothesis that assignments with those characteristics were most likely to be completed as planned. The criteria are definition, soundness, sequence, and size.

The next component developed was the identification and tracking of reasons for not completing planned tasks. This was driven by the realization that perfect planning is impossible in conditions of high uncertainty and complexity, which were thought to be characteristics of at least most construction projects. However, we can aspire to avoid repeating the same mistakes. In order to do that, reasons must be analyzed to root causes and action taken to eliminate them.

At some point, it was realized that the practice of making only quality assignments and learning from plan failures would improve labor productivity to some extent, but would not assure that the right amount of work of the right type was being done in the right sequence to achieve project schedules or to best match load and capacity, the base condition for good productivity. Consequently, lookahead planning was introduced. Lookahead plans are drop downs from a higher level schedule, looking into the future typically 3 to 6 weeks, dropping the past week and adding a new 6th week each week.

The last component of Last Planner was added in order to link production control to the project schedule. The researchers' experience was that many project schedules required extensive rework once they entered the lookahead window. Further, it was realized that the handoffs or release of work from one specialist to the next was the critical focal point of control, and that project schedules rarely made those handoffs explicit. Consequently, the practice of phase scheduling (now usually referred to as 'reverse phase scheduling') was introduced.

From the early developmental period, benefits of using the Last Planner system began to be evident. On a large industrial piping project, data analysis revealed an average difference in performance against budget of 30% between crews with PPC <50% and those with PPC >50%. After this, there have been numerous reports on the positive productivity impacts of the Last Planner. In addition to these benefits, and arguably even more important, were the observed effects on culture and teamwork.

3. Towards theory of lean production control

Three domains of theorizing for lean construction have emerged: theory of production [2], theory of management [3] and metaphysical underpinnings [4]. Theory of management can be divided into theories of planning, execution and control. In the following, Last Planner, along with the conventional production management method, is analyzed based on this work.

Regarding theories of planning, Last Planner subscribes to the view of human action as situated - a foundational assumption of *managing-as-organizing*, while also acknowledging the significance of plans for action - as advocated by *managing-as-planning*. Conventional production management subscribes only to management-as-planning, and is thus inherently incapable of responding to changing situations.

Regarding the execution phase, Last Planner is similar to the *language/action perspective* model in that communication is a two-way process, and commitment is created for the realization of the tasks by letting the crews influence the weekly plan, by explicitly requesting whether a promise can be made, and through the obligation to report on the completion of the task. In conventional project management, execution just consists of task authorization. Theoretically, execution is thus reduced to one-way communication, as covered by the *classical communication theory*.

In conventional project management, main control consists of comparing progress with the performance baseline, expressed in money or hours. This *thermostat model* is the cybernetic model of management control. In Last Planner, control consists of measurement of the realization rate of assignments, investigation of causes for non-realization and elimination of those causes. Theoretically interpreting, Last Planner is using the *scientific experimentation model* of control.

Conventional production management is heavily based on the concept of tasks, which is based on the *transformation theory* of production. This can be shown to directly lead to practical problems [2], as this foundation of production is an idealization, and in complex production settings the associated idealization error becomes unacceptably large. Tasks are the central unit of analysis also in Last Planner. However, remarkably, the principles used in Last Planner contribute to the generic principles of flow management. The *flow theory of production* is thus utilized. It can also be claimed that Last Planner is using the suppression of the *waste of making-do* as a driver towards reducing variability and improving the whole production system.

The traditional conception of production as transformation (of one set of things to another set of things) is implicitly based on *thing metaphysics*. Last Planner falls into the group of correctives based on *process metaphysics*.

4. Conclusions

Last Planner is based on a different or wider theoretical foundation when compared to conventional production management. In all major aspects, conventional production control falls theoretically short in comparison to Last Planner. Thus, the problems related to conventional production management are theory-driven.

What is then Lean Construction – 2006? At one level the answer is invariant: As since its origin, lean construction is a scientific-industrial movement, inspired by the Toyota Production System, aiming at renewing the fundamentals of production management in construction. However, at another level, the answer is dynamically changing, as understanding and practice evolve. This paper has given a snapshot for the situation in 2006 regarding production management in construction.

References

[1] Ballard, Glenn (2000) The Last Planner System of Production Control. School of Civil Engineering, Faculty of Engineering, The University of Birmingham.

[2] Koskela, Lauri (2000) An exploration towards a production theory and its application to construction. VTT Building Technology, Espoo. 296 p. VTT Publications: 408.

[3] Koskela, Lauri; Howell, Greg (2002) The underlying theory of project management is obsolete. Proceedings of PMI Research Conference 2002. Slevin, Dennis, Cleland, David & Pinto, Jeffrey (eds.). Project Management Institute (PMI), 293 – 302.

[4] Koskela, Lauri, Kagioglou, Mike, (2005), On the Metaphysics of Production, -The 13th IGLC Conference, Sydney.

Building science education: A global versus local view of design and construction

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Alternative contractual delivery systems, collaborative partnerships, new management initiatives, and evolving product markets require American students to have a broader awareness of construction issues in a global context. Therefore, the department of Building Science (BSCI) at Auburn University created a 5-week, 6-city, faculty-led, European Study Abroad class for the summer of 2000. The success of the 2000 class was repeated in 2002, 2004, 2005 and the next class will be conducted during the summer semester of 2006. This paper describes the design, development, and evolution of the study abroad classes, along with the course objectives, structure, and outcomes.

Keywords: Construction Education, Study Abroad, Experiential Education.

1. Introduction

The design and construction industry makes up 8 – 10% of the United States' GDP (Gross Domestic Product) and an even larger percentage of some developing countries' GDP. Issues concerning the use of public and private funds for the built environment touch every individual one way or the other. Furthermore, local and regional construction firms are becoming increasingly more international and the role of the construction professional now includes many front-end services that require an increase in the skill set of new university graduates. Alternative contractual delivery systems, collaborative partnerships, new management initiatives, and evolving product markets require American students to have a broader awareness of construction issues in a *global context*. Many academic disciplines outside of construction education (i.e. foreign languages, art, music, architecture, etc.) have successfully used study abroad programs as an effective means of broadening university students' academic, personal, and professional views of the world. Therefore, the department of Building Science at Auburn University created a 5-week, 6-city, faculty-led, European Study Abroad class for the summer of 2000. The success of the 2000 class was repeated in 2002, 2004, 2005 and the next class will be conducted during the summer semester of 2006.

2. Summer 2000 Class

Based on the success of Auburn University's School of Architecture's 30-year history of traveling with students throughout Europe during the spring term, the department of Building Science proposed a similar faculty-led traveling study abroad class. However, the Building Science class would take place during the summer semester of 2000 rather than in the spring. This initial class actually consisted of two separate 3-credit courses, a preparation (prep) class and a special topics (elective) class. The class make-up consisted of the instructor, 4 Building Science graduate students, and 1 graduate student/instructor-in-training Scott Kramer. The itinerary included spending 1 week each in 6 European cities and 2 weeks of free travel. The itinerary was as follows: Paris, London, Barcelona, Copenhagen, Rome, and Berlin. Each student kept a travel journal during the class, which was graded by the instructor while everyone was in Europe. Also, each student completed a written assessment of each class visit or event attended during the summer. This assessment was part of the grant requirements set forth by the College and would provide valuable feedback for: (1) evaluating the class, (2) consideration of continuing the study abroad program, and (3) future class itineraries, structure, region chosen, and type of visits. Based on positive assessment from the 2000 class, the department of Building Science decided to continue the study abroad class and offer it every other summer if students showed interest.

3. Summer 2002 Class

Again, the 2002 study abroad class actually consisted of two separate required Building Science classes. One was an alternative senior capstone class and the other was the Contracting Business class. By offering these two courses together, the senior students could graduate 1 semester early and complete their required senior capstone project during the 10-week summer semester, rather than the following fall semester as the curriculum dictated. Six students participated in the 2002 class, five seniors and 1 junior, plus Associate Professor Scott Kramer. The junior student only participated in the Contracting Business class for course credit and completed the regular senior capstone class the following summer term.

The overall goal of the 2002 class was to expose students to construction-specific companies, projects, practices, and project management professionals that they would never be exposed to otherwise. There were three construction-related visits per city (e.g. construction projects, material suppliers, construction firms, equipment manufacturers, etc.). Students visited with construction professionals and collected data from 5 of the top 10 international construction firms [1]. Some of the other visits included: marble quarries in Carrara, concrete pump manufacturers in southern Germany, renovation of the U.S. embassy in Rome, renovation of the War Cabinet Rooms in London, and the construction of a new development in Copenhagen. Also, there was one cultural event per city (e.g. ballet, opera, concert, musical, etc.). The students collected original source documents (e.g. transcribed interviews with key executives, photos, company brochures, company training material, videos of visits, etc.) during the 5-week traveling half of the 10-week summer semester. After returning from Europe, the second 5 weeks of the semester was dedicated to developing and completing the written capstone projects.

3.1 Outcomes and Assessment

Students were required to write an original research paper and create a 30-minute PowerPoint presentation that would be presented and defended to a jury of Building Science faculty. The student's grade was based 75% on the written paper and 25% on the PowerPoint presentation. All five students completed their senior capstone projects by the end of the summer semester 2002. All of the students that participated in the study abroad class are very enthusiastic about the continuation of the program and are actively marketing the study abroad program to students currently in the Building Science program.

4. Summer 2004 Class

Due to the U.S. terrorist attacks on 9-11-2001 and the later cooling of attitudes and relations between the U.S. and Europe, family members and friends were concerned about staying in touch and tracking the groups' travel abroad during the 2004 summer semester. While email is an important way of staying in touch, it does not offer a shared discussion environment that would serve as a travel log desirable for this group trip. After exploring the popular communication options of web blogs, travel blogs, newsgroups and Wikis, a WebCT™ [2] site was developed instead. Perhaps the most meaningful use of the course software was the virtual travel log created using the discussion forum in WebCT™. At the start of the trip, the Building Science department supplied five notebook computers, each shared by two students. These computers were used for storage of digital images, for composing reflection statements, and for recording travel and contact information. Publicizing and marketing future Building Science Study Abroad classes will be made easier with the self-documenting features of the WebCT™ Travelogue. Prospective students and their parents can see photos, threaded discussions, and the itinerary of the 2004 class by viewing it as a link from the main Building Science web page at www.bsci.auburn.edu.

5. Conclusions

The overall goal of each class is to expose students to companies, projects, practices, and construction management professionals that they would never be exposed to otherwise. Another major goal of each class is to expand the students' academic, professional, and personal views of the world from *regional to global*. Additional course learning objectives include:

- exposure to different construction methods, materials and equipment
- professional project management practices in international construction
- the unique aspects of historic preservation and restoration projects
- understanding project delivery methods used in global projects
- view world-class performing arts and fine arts
- view monumental and historical architecture
- experience different cultures, currencies, transportation systems and languages

Studying abroad is an invaluable experience – for many students, a once-in-a-lifetime opportunity to live in a foreign country, to experience its customs and culture, and to adapt to new surroundings [3].

References

[1] ENR (2002) Engineering News Record: 2001 ENR Top 225 International Contractors, Retrieved May 1, 2002, from the World Wide Web: http://www.enr.com

[2] WebCT (2004) course management software or e-learning environment provided to institutions of higher learning worldwide, from the World Wide Web: http://www.webct.com

Design parameters of research and development performance measurement in construction

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Utilisation of Performance Measurement (PM) systems within construction Research and Development (R&D) would generate maximum benefits by evaluating their successfulness, improved communication, and coordination, identifying future improvement areas. This paper critically analyses and evaluates the design parameters, factors that influence the selection of the design parameters in both the general and R&D specific PM literature.

Keywords: Design parameters, Construction, Performance measurement, Research and development

1. Introduction

One of the main reasons behind the under performance of the construction industry is recognised as insufficient research and development (R&D) activities and innovations [1]. Macmillan [2] and Fairclough [3] argue that research and innovation in the construction industry have a significant role to play in performance improvement while providing benefits to the industry as well as to its stakeholders. R&D activities require many resources ranging from human to technical which require proper utilisation. A growing interest can be identified in managing, controlling, and monitoring these resources and R&D activities [4]. In this context, the use of performance measurement (PM) benefits the R&D activities by evaluating their successfulness. In terms of the UK construction research base in particularly to the academic research, lack of evaluation criteria to assess the research output against the research goals is evident [5]. The non existence of such validation/feedback and evaluation mechanisms within the academic research has been identified as a "fundamental missing link" for researchers, research users, and funders [5]. This paper reviews the design parameters and factors that influence the selection of the design parameters when designing a R&D PM system.

2. Characteristics of good performance measurement systems

To overcome the associated problems with the traditional performance measure, number of PM systems has been developed over the past years by integrating multiple performance measure. Further, the need of linking the strategy of the organisation with the performance measures has been well highlighted. In addition to the above, performance measures should be simple in understanding, should have a visual impact, focus on improvement of the organisation rather than on variance, visible to all, provide timely and accurate feed back, and have a specific purpose.

3. Design parameters of research and development

PM system has to characteristic with certain elements which are called as design parameters. Kerssens-van Drondelen and Cook [6] define Design Parameters as the "topics that need to be addressed when developing a measurement system". They identify the main parameters of R&D PM as performance measures, measurement system structure, standards or norms that the performance will be evaluated, measurement techniques, frequency and timing of measurement, and reporting format. By reviewing the general literature and through a survey, Neely et al [7] develop a "performance measure record sheet" which identifies the topics that has to be addressed in PM. This record sheet also includes the performance parameters identified by Kerssens-van Drondelen and Cook [6] such as title (performance measure), target (standards), formula (technique), frequency of measurement and reporting format. In addition to that, Neely et al [7] goes on to identify specific factors that are built around the above parameters. They are who measures the performance, sources of data that should be used, who owns the measure, who act on the data. These parameters tend to identify the ownership for measurement procedure and for final data. By doing so, the successful implementation of PM, prompt and appropriate follow up actions based on the results are ensured.

4. Factors that has to be considered when selecting design parameters

Various studies have shown that the factors such as nature of competitiveness [8], innovation, and project strategy of the organisation [9], size of the organisation, type of R&D activities carried out within the organisation influences selection of design parameters of R&D PM [10]. The organisation level at which the R&D PM takes place (subject of measurement) has a significant influence on the selection of the design parameters [6]. They argue that the design parameters such as frequency of measurement, norm setting, and measurement technique are influenced by whether the PM is done at individual, departmental, or organisational level. In addition to that, purpose of measurement (whether it is to motivate the people, to evaluate the successfulness of the activities), and objectives formulated for the subject of measurement are some other factors which have to be considered when selecting design parameters. Further more, simplicity of understanding, operating and interpreting the data [11], availability of data [11], [10] nature of data (whether it is quantitative or qualitative) required by the PM system, cost of implementation in terms of monetary value and time consumption [11] are identified as some other important aspects that influence the selection of design parameters. Further Poh et al [11] state the risk and uncertainty of R&D activities and ability of the method to incorporate experience and knowledge of different people within the R&D setting are also influence the selection design parameters.

5. Discussion

The inadequacy of financial measures as the sole criteria of PM has been criticised over the past decades leading the path to develop comprehensive PM systems by taking into account financial, non financial, external, and internal factors. The developments identified within the general PM literature have been experienced even within the R&D settings. The design parameters identified from the literature review will ensure that a PM system will consist with all the important elements. Consecutively this will provide comprehensive information on which the management can evaluate the success or failure of the organisational activities. Further, some of the design parameters assign ownership of activities to employees, which will ensure the continuous evaluation without any interruption. The selection of these design parameters is influenced by number of factors. From the literature review authors categorise them into three main groups. Firstly there are organisational specific factors which have to be considered when selecting an appropriate design parameter. They include innovation and organisational strategy, size of the organisation, type of R&D the organisation engaged in, type of industry, and risk and uncertainty of the R&D work. Secondly, there are factors which influence the selection of performance parameters depending on the main requirements or the priorities of the organisation. For example purpose of measurement, the stage of R&D which PM system is implemented and the level at which the performance is measured can be taken. These influential factors will be decided in such a way that the key organisational activities are prioritised and ultimately achieve its aims, objectives, and strategies. The third group show the extent which the organisation would like to commit themselves when selecting design parameters. These factors show the amount of effort and resources that the organisation would willing to allocate for PM system. They include how far the organisation is prepared to use the experience and knowledge of the employees, time and cost commitments in designing the system. As the concluding remarks, it can be said that the appropriate selection of design parameters blend with good characteristics of PM systems would generate satisfactory results for the organisation. Such a PM system would generate timely and accurate information about the current success and future improvement areas where the organisation can rely and act upon.

6. References

[1] Dulaimi, M.F., Ling, F.Y.Y., Ofori, G., and De Silva, N. 2002, Enhancing integration and innovation in construction, *Building research and information*, 30.4, 237-247

[2] Macmillan, S. 2002, The right vision for construction R&D? Responding to the Fairclough Review, *Building Research & Information*, 30. 5, 328- 333

[3] Fairclough, J. 2002, *Rethinking construction innovation, and research: A review of government R and D policies and practices*, Department of Trade and Industry, London

[4] Bone, S., and Saxon, T. 2000, Developing effective technology strategies, *Research technology management*, 43. 4, 50-58

[5] Lorch, R. 2000, *Improving the communication of academic research to the construction industry*, CRISP, (accessed 20th February 2006), available online from: http://ncrisp.steel-sci.org/Publications/9916frLo.pdf

[6] Kerssens-van Drongelen, I. C., and Cook, A. 1997, Design principles for the development of measuring systems for research and development process, *R&D management*, 27. 4, 345-357

[7] Neely, A, Richards, J. M, Ken, P. and Bourne, M, 1997, Designing performance measures: a structured approach, *International journal of operational management*, 17. 11, 1131-1152

[8] Loch, C., Stein, L. and Terwiesch, C. 1996, Measuring development performance in the electronics industry, *Journal of product innovation management*, 13, 3-20

[9] Griffin, A., and Page, A. L. 1996, PDMA success measurement project: recommended measures for product development success and failure, *Journal of product innovation management,* 13.5, 478-496

[10] Werner, B.M., and Souder, W.E. 1997, Measuring R&D performance – state of the art, *Research Technology Management*, 40.2, 34–42

[11] Poh, K. L., Ang, B. W. and Bai, F. 2001, A comparative analysis of R&D project evaluation methods, *R&D management*, 31.1, 63-70

A road map for the development of transport infrastructure management

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The Finnish infra sector has launched a development programme to improve the efficiency of transport infrastructure management. This paper introduces a road map that identifies the development efforts required to reach the goal. It consists of co-ordinated theme-based sub-road maps of a) product model and data transfer, b) operational modes and project processes, and c) eco-efficiency and life-cycle know-how.

Keywords: infrastructure, product models, procurement systems, environmental impact, service life

The Finnish infra sector, including major public owners and the construction industry, has launched a joint development programme to improve the efficiency of transport infrastructure management involving the procurement and implementation of design, construction and maintenance, especially of major roads and railways. The programme is called *Infra 2010* [1].

This paper introduces the results of the programming phase intended to identify the development efforts required to reach the goal. The guidelines for the programming were produced by a feasibility study [2] which defined the themes and objectives of the programme as presented in Table 1.

The results consist of three co-ordinated theme-based sub-road maps each defining ten or more interrelated key development activities (Figs. 1–3). The examination focuses on unexploited possibilities, actual development activities, and to some extent on their interrelations. Thus, the emerging general Road Map (with textual portions) should form a relatively coherent entity describing the appropriate path(s) to follow in the current Finnish situation. Yet, it is only a preliminary stage framework proposal and binds no one as a guideline plan.

[1] INFRA 2010. Kehitysohjelmalla lisää tuottavuutta. [INFRA 2010. Improved productivity through a development programme] (2006) (in Finnish) Web document available at:
http://www.asuntotieto.com/INFRA2010/

[2] INFRA 2010 -ohjelman esiselvitys [Feasability study for INFRA 2010 programme] (2004). The Finnish Confederation of Construction Industries, etc. 47 p. (in Finnish)

Table 1. Aims of programme's main themes [2].

Aim	Main results/impacts
A. Product model and data transfer	
The aim is to develop, prepare and test a future product model-based design and building process, life-cycle management and the required definition, organising, storage and transfer of product data.	• quicker and more effective design • improved quality and productivity • more effective life-cycle management • better customer service
B. Operational models and project processes	
The aim is to develop sector operational models and project processes to support development of new and more integrated services and effective introduction of product model.	• procurement methods promoting innovativeness • evaluation of product and service performance • wider use of development as part of production • risk optimisation and allocation models
C Eco-efficiency and life-cycle know-how	
The aim is to develop life-cycle know-how comprehensively to be able to design and produce infrastructures that meet the requirements of owners, users and society during the entire life cycle in a controlled and optimised manner.	• procurement methods that consider life cycle • life-cycle cost evaluation methods • service-life and degradation models • eco-efficiency indicators (ecoindicators) • product approval procedure for new products

Figure 1. Development tasks and paths of 'product model and data transfer' part (part A).

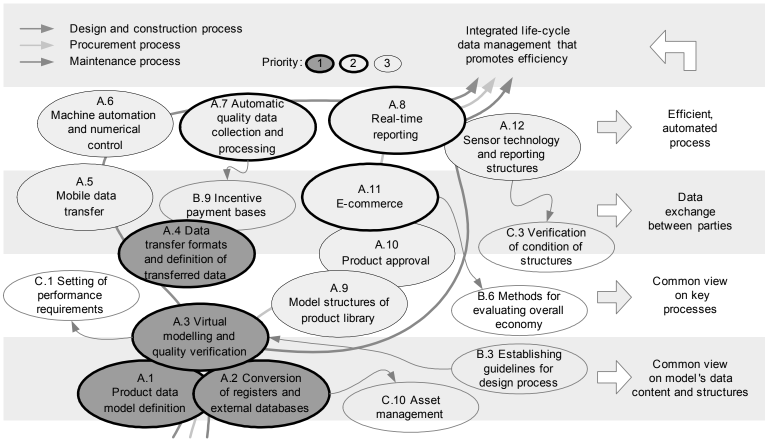


Figure 2. Development tasks and paths of 'operational models and project processes' part (part B).

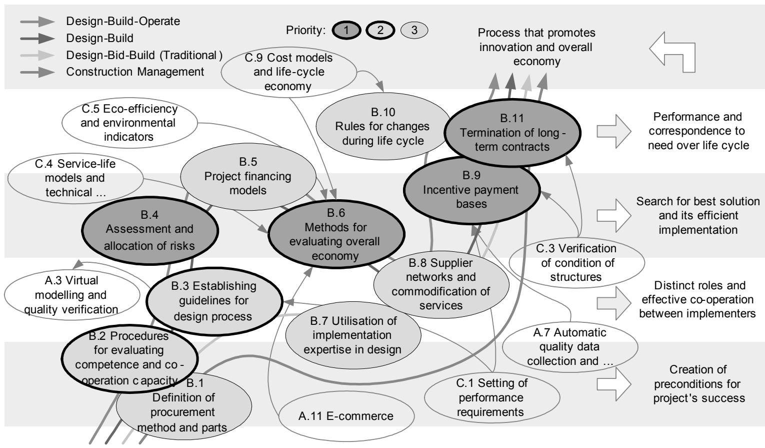
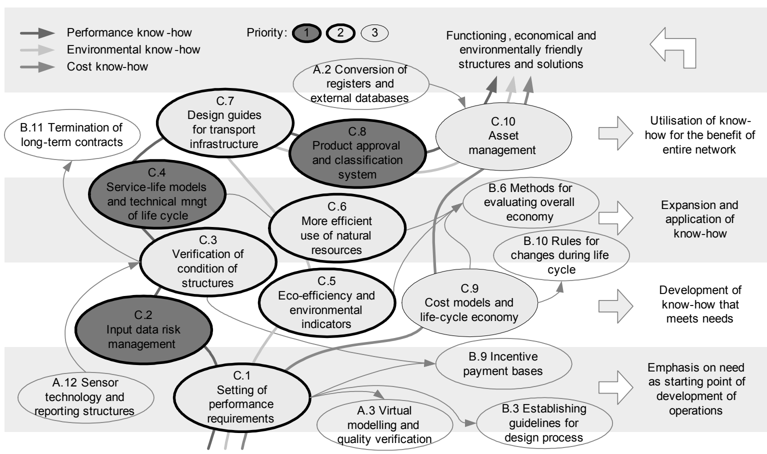


Figure 3. Development tasks and paths of 'eco-efficiency and life-cycle know-how' part (part C).



Integration of lean design and lean construction – a cognitive path dependency view

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The lean organisation principle has been widely applied to production in building construction during the past decade. The application of lean organisation to other fields in the value chain at a wider scale intends to strengthen integration which in turn is expected to result in considerably improved productivity. This is particularly expected in terms of reduced costs through diminished waiting time, fewer failures in production, and reduced need for corrections of drawings and plans, etc. The prime intention of the present study was to evaluate whether the integration of lean design management and lean construction produced the expected benefits or uncovered new problems.

Keywords: Lean construction, institutional barriers, path dependency.

1. Introduction

The organisation of activities in building construction is characterised by complexity, many actors, time constraints, often difficult site conditions, and large amounts of production components. At the same time this complex product system [1], [2] with many interfaces between and in-between planning and operational units seems particularly vulnerable to waste, process errors, and defects in the final products. To overcome the traditional deficiencies of the construction process many management and quality process initiatives have been introduced over the years. Among the most recent is the lean construction model which is the principle of lean manufacturing originally known from car manufacturing in Japan [3].

A basic assumption of lean manufacturing is that lean "has a clear set of objectives for the delivery process, is aimed at maximizing performance at the project level, designs concurrently products and process, and applies production control throughout the life of the project" [4]. The basic foundation is the pursuit of perfection in the sense that failure to meet the unique requirements of the customer is defined as waste.

2. The lean principle in the construction industry

Today the principles of lean construction are used in many construction firms. It is directly inspired by the lean production concept or lean manufacturing in Japanese car manufacturing, earlier also known as just-in-time organisation. Researchers at Stanford University [5] suggested this new production philosophy should be applied to construction and especially in the past decade the methods have been implemented and have continually been further developed and improved in many construction projects.

The construction project that is analysed in this paper was realised by one of the largest building contractors in Denmark. In addition to the textbook prescription, the company has supplemented its implementation model with other features. Overall, the model applied by the contractor features the following components:

- Dynamic planning with weekly work plans and 5-week look-ahead plans at weekly meetings..
- Weekly evaluations (Percent Planned Completed) and schemes summarising reasons for delays.
- A colour code is used to indicate the status of specific work items to ensure that the activities released by the look-ahead plan to the last planner are “sound”.
- Material Logistics, including planning of large deliveries and a site plan. (This is only dealt with in the construction phase).
- A planning system developed by the contractor to support lean planning and pull-logistics.
- The process manager acts as the coach of the building site [6].

3. Path dependency and organisational change

The introduction of lean construction principles will in most cases represent a process innovation to the particular firm that introduces this new production management philosophy. When management introduces lean in construction firms, it is with the explicit aim to make the workflow continuous and reliable, reduce waste, and increase the value delivered to the customer, in other words to put an end to previous practices that result in waste, delays, and defects and instead make the organisation move in a new direction. What determines the organisation's ability to change its course is the context of its sense-making pattern [7] and the way it constructs meaning, in other words the organisation's cognitive path [8]. This makes the application of lean something of a paradox as the intention of its application is to change organisational sense-making while the success of its initiation depends not on being in conflict with the organisation's existing sense-making.

While knowledge management, lean construction and other strategic tools apply methods that enhance transparency and well documented procedures, the contributions of individuals that make up the core of the organisation's sense-making may often be neglected. Therefore, the role of management becomes core, to ensure the success of a new path creation through for example the appliance of lean construction principles and methodologies.

4. Methodology and data

Data were assembled by means of a longitudinal case study running over a period of 24 months. Thus, the study covers all phases of the construction project from the earliest design work to the completion of the buildings.

There were three main collaborators, a main contractor, an architect and a technical design company (consulting engineer) and moreover a variety of suppliers and subcontractors. The building project was both designed and implemented in a lean construction production model.

Data collection has encompassed a variety of methods including

- Review of specific lean planning tools
- Observation at the construction site
- Questionnaires followed by focus group interviews
- A survey of data collected at a number of construction sites

5. Findings and analysis

The design phase was successful with respect to the lean principles set out by the managing partner (the contractor). The process was characterised by uncomplicated team sprit where crises were dealt with professionally and hence, potential conflicts were prevented. The work plan (last planner) applied as one of the core tools for lean design management was especially popular. Also the project meetings were highlighted as actual working meetings with a better outcome than traditional project meetings.

The investigation also showed that four out of five respondents experienced being subject to delays caused by others. The delays appeared to be a result of several factors, and hence it proved that some elements in the process could be improved. The most important ones were:

- Low quality of project material and project plans
- The specific work site was not cleared at the agreed time
- The accessibility of the site was difficult due to the type of building or general lack of clearing the site / removal of material

References

[1] Winch G. (1998) Zephyrs of creative destruction: understanding the management of innovation in construction. Building Research & Information, 26(5), 268-279.

[2] Winch G. (2006) Towards a theory of construction as production by projects. Building Research & Information, 34(2), 164-174.

[3] Womack J.P., Jones, D.T. and Roos D. (1990), The machine that changed the world. Harper-Collins, New York.

[4] Howell G. and Ballard G. (2002) What is lean construction? located at http://www.acci.unsw.edu.au/ Documents/LeanConstruction.pdf

[5] Koskela L. (1992) Application of the new production philosophy to construction. Technical Report No. 72, Center for Integrated Facilities Engineering, Dept. of Civil Engineering, Stanford University.

[6] Thomassen M. A., Sander D., Barned K.A. and Nielsen A. (2003) Experience and results from implementing lean construction in a large Danish contracting firm. Proceedings of the 11th Annual Conference on Lean Construction, July 22, 2003, Blacksburg.

[7] Weick K. (2001) Making sense of the organization. Blackwell, Malden.

[8] Choo C.W. (1998) The knowing organization: how organizations use information to construct meaning, create knowledge and make decisions. Oxford University Press, Oxford.

Understanding competitiveness: polarized perspectives and the search for the middle ground

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Previous research into construction sector competitiveness is replete with different ontological, epistemological and methodology positions. When combined with the problem of defining what 'competitiveness' means, this methodological diversity has created an impasse in the field. Previous attempts to understand competitiveness have focussed upon either the structural or cultural aspects of the sector. Researchers have further been preoccupied with separating industry, firm and actor levels of understanding, viewing them as separate and unrelated rather than interconnected. An alternative perspective is developed based on the tradition of critical realism, ontologically embedded in the agency structure paradigm, avoiding polarized perspectives that frequently conceal more than they reveal. This offers a fresh perspective from which to understand the dynamics of competitiveness avoiding polarized traditions.

Keywords: agency, competitiveness, critical realism, integrative approach, structure

1. Introduction

Previous researchers have adopted different ontological and epistemological positions when researching competitiveness. Traditionally construction management (CM) approached the subject of competitiveness by looking at the structural aspects of the industry [1]. Such studies tend to accord with the 'structure' dimension [2]. More recently the relevance of actors has generated interest within construction management [3]. This sits more closely with 'agency' dimension [2].

2. Structure

The traditional approach to understanding competitiveness focuses upon the structural elements of the social system, taking an exogenous position. This tends to view reality in an objective way, where actors play a largely passive role. CM literature embraced much of Porter's (1995) thinking, with much research adapting and building upon that framework.

3. Agency

The agency approach places more emphasis upon how individuals interpret their surroundings and what things mean to them. Such a focus often leads to qualitative data. This approach has made significant gains during recent years in construction management literature.

4. Middle ground

Critics often initially seek to combine quantitative and qualitative data, whilst others claim that the 'problem of structure and agency has rightly come to be seen as the basic issue in modern social theory' [4]. Researches avoiding polarized views are rare in CM, although they are slowly beginning to emerge.

5. Critical realism

Critical realism (CR) is an umbrella term for a number of positions arguing that there exists an objectively knowable, mind-independent reality, whilst acknowledging the role of interpretation by actors. CR is ontologically embedded in the agency-structure perspective of social theory and thus is seen as one of a number of integrative approaches. The following section outlines the themes upon which CR is built. *Interpretations of reality* - Unlike the approaches described, CR breaks down understanding into key themes, materially, ideally, artefacturally, and socially real. Restrictions mean an explanation of this is not possible here, however, these allow reality to be viewed in different forms or layers. *Causal powers* - Based upon the modes of reality above; the central epistemological issue for critical realists is the search for causal mechanisms. It is these causal mechanisms which are of greatest interest, and their powers to permit or impede something occurring. *Open systems* - It is argued that social phenomena occur in open, unconstrained systems [7]. The closed, controlled systems adopted by the objective perspective are unavailable. *Stratified understanding* - This builds upon the notion of an open systems perspective.

These considerations cause critical realists to argue that reality is stratified [7]. This means that the emergent powers cannot be broken down into their parts in order to gain an understanding of them. They must be considered together, as a whole. Social reality, through the accumulation of causal powers, is greater than the sum of its parts. This empathizes with competitiveness being viewed as a discourse, whereby it is an ever changing manifestation depending upon its context, with a number of interconnected attributes each with causal powers. *Striving for truth* - Critical realists search for a true account of reality and that reality exists independently of our minds, our theories, observations. This is an acceptance that researchers will never truly find what they are looking for as no method is infallible. The notions of interconnectivity and complexity are central and highlight that critical realists view social phenomena occurring without constraints.

6. Conclusions

This paper has highlighted a weakness in the approaches used to study competitiveness. The literature review demonstrated the polarized perspectives adopted conceal more than they reveals. Whilst research within the field has not adopted such a perspective from which to view competitiveness, ongoing research will develop a methodology to do so. This will establish a grounded understanding of the suitability of the perspective directly related to sustained competitiveness. This will have potential implications for other areas within this complex social setting.

References

[1] Bowley, M (1966) *The British Building Industry: Four Studies in Response and Resistance to Change*. Cambridge University Press. London

[2] Whittington, R (1988) Environmental structure and theories of strategic choice. *Journal of Management Studies* 25 (6) 521-536.

[3] Green, S D (1998) Technocratic totalitarianism of construction process improvement: a critical perspective. *Construction Management and Economics* 14 (2) 155-164.

[4] Archer, M, (1988) Culture and agency: the place of culture in social theory. Cambridge University Press. Cambridge.

[5] Ackroyd, S and Fleetwood, S (2000) Realist perspectives on business and organization. Routledge. London.

[6] Costello, N (2000) Stability and change in high-tech enterprise. Routledge. London.

[7] Bhasker, R (1978) *A Realist Theory of Science.* Harvester Press. Hassocks. UK

Weather protection systems: Experiences from three construction projects

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During the last 10 years one of the discussions in the Swedish construction industry has been the feasibility of Weather Protection Systems (WPS). Some actors in the building industry advocate that it secures the quality of the building and improves the productivity while others claim that the costs for the WPS are far too high.Three different construction projects with WPS during the production were evaluated in order to estimate benefits and costs from the WPS. The results showed that the WPS did function well; effects such as shorter time schedules, more precise delivery times and use of different production methods were shown. Comparisons with other similar projects show that the rental cost of a roof sheltering system is roughly 2-5% of the production cost and that WPS give more effects than just an improved work environment and increased quality of the finished product.

Keywords: Industrialized building, weather protection system, productivity, cost/benefit-model

1. Introduction

Industrialised building could be defined as a way for the whole building industry to build houses at a lower price and with an improved quality. An industrialised building process would resemble and be more similar to the stationary industry. One way to industrialise the building process is to shelter the construction work and protect it from precipitation, wind and temperature. Three construction projects with exposited WPS were followed and evaluated in order to find and structure all costs and benefits.

2. The three projects

The “Gothenburg-project” was a reconstruction project of a University building that took place during 2005 in the Swedish city of Gothenburg. The reconstruction lasted for twelve months and was weather protected during a period of six months. The reconstruction mainly consisted of building an additional storey onto an existing building. The WPS was designed by PERI, and specially adapted for this project. The system stretched over an area of 35x48m and raised 10.5m over the top storey. It rested on two rails making it to a mobile system that could be opened.

A total reconstruction of a building within the University of Karlstad took place during 2003. The reconstruction consisted of a remodeling of two storey and adding two new staircases and a completely new prefabricated top storey. The new top storey would also contain two new fan-rooms. In total, the reconstruction consisted of 10 000m2. The chosen WPS was a Hakitec 750-system mounted on rails which allowed the system to be opened. The system was 120m long, 34m wide and raised 10m over the top storey. The maximum opening was 12m, which made it possible to transport material through the WPS to the building site. In the city of Sundsvall the production of five new solid-wood multi storey houses started in the middle of 2004 and they were finished during 2005. Due to the moist sensitivity of the wooden framework, the solid-wood houses had to be produced under a climbing WPS, a Gibson Tower system. The WPS itself was built up by five meters wide alumina-sections. The sections were resting on towers which were supplied with motors which would allow the climbing.

3. Cost/Benefit model

Rental costs for WPS can vary greatly depending of the required span, type of production and the shape of the building.

	short-term factors	long-term factors
soft factors	The work environment was radically improved. Some of the WPS had minor technical problems.	A better image for all involved parties is anticipated.
hard factors	The estimated benefits were about equal to the estimated costs.	Use of WPS will on long tern reduce the maintenance costs as very little moisture will come in contact with the building material.

Figure 1. A four-field model showing costs and benefits from the use of WPS

Normally, the cost for mounting, renting and maintaining a WPS represents 2-5% of the production cost. However, it is relatively easy to estimate those “hard” costs and benefits which are related to the project budget, but it is much more difficult to estimate the long and short term soft factors of the WPS. The model in figure 1 [3] is used to compare WPS benefits and costs in the three projects.

3.1 Short-term and hard factors

One factor that will influence a cost-estimation it the decreased duration of the production 20-30% compared to a production without WPS. The second one shows that the efficiency of the craftsmen is lowered when the production is under the influence of rain, snow, low temperatures or wind. A relatively small weather impact will reduce the efficiency of the craftsmen of 40% [4].

A large profit besides the ones earlier mentioned is the amount of hours connected to the lead time. Protecting the site for instance tarpaulin in mornings, evenings and breaks adds an additional two work hours every day. In some cases a WPS will provide with the opportunity to use more effective production methods, which normally not are used outdoors. Experiences also show that the amount of construction errors will be reduced.

3.2 Short-term and soft factors

The projects showed that there were some technical problems with the WPS e.g. the complicated opening and closing of the some of the systems. A more difficult problem was the logistics as e.g. the mounting of prefabricated slabs which required large openings of the WPS. On the other hand, the efficiency of the logistic was increased since the demand on a more precise planning becomes more important because of the need for accurate material deliveries.

In all the three evaluated projects there is one aspect that is re-occurring – the improved work environment. Interviewed craftsmen were convinced that a WPS provides a healthy work environment and it was obvious that the absence of illness was reduced.

3.3 Long-term hard and soft factors

In the long-term the usage of WPS will affect the future in two ways. Firstly, the probability that the buildings are built with a higher quality will rise since the risks connected to moisture damages are reduced. This will lead to a reduction of the operation and maintenance costs. Secondly, buildings with higher quality will in the long run provide the building sector with an improved image.

4. Conclusions

In the research project by Larsson and Söderlind [2] 2006 three WPS of different fabrication were used. The conclusion from the report [2] along with information from additionally nine projects [1] clearly show that the systems are technical feasible but technical development is needed. It is profitable to use a WPS especially as the soft factors e.g. work environment was radically improved. However, the decision to use a WPS is commonly taken very late in the building process. The full potential of the benefits from the WPS is therefore not gained.

To gaining all of the benefits, it was apparent that the client must take the initiative. In the report [2] it was stated that it is in most cases an advantage if the client takes the decision to use a WPS early in a planned building project. If so, it becomes possible to design the house, the process and the building site and optimise the positive effect from the WPS.

It is difficult to think that in the future a construction project under an open sky will be categorised as “industrial building”. This problem could be solved in many ways, one is weather protection systems (WPS) could be an optimal solution for many future building projects.

References

[1] Axelson, K., Larsson B., Sandberg, S. och Söderlind, L. (2004). *Väderskyddad produktion, Möjligheter och erfarenheter*,(Weather protected production; Possibilities and experience) FoU-Väst RAPPORT 0404

[2] Larsson B. och Söderlind, L. (2006). *Väderskyddad produktion, Framtidens byggande*, *(Weather protected production; The future building)* FoU-Väst RAPPORT 0604

[3] Claeson-Jonsson, C., Jirebeck, M. och Larsson, B. (2005). *Räkna med ny teknik – om konsten att välja rätt*, (Calculate with new technology – the art of choosing right) en NCC-Rapport, 41 sidor.

[4] Noreng, K. (2005). *Vaerbeskyttet bygging med Wheather Protection Systems (WPS*), *(Building with Weather Protected Systems WPS)*, BYGGFORSK, Norges byggforskningsinstitutt, Rapport 119-2005

Construction sector skills shortage in New Zealand: an analysis of causes and effects

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The objectives of this paper are to provide an overview of the current construction skills shortage in New Zealand and its relationship to the wider economy; to analyse the reasons for the shortage; and explore potential solutions. The paper is based on recent research during which information and opinions were gathered through email surveys, interviews with key industry employers and a literature review.

A number of factors that combine to cause fluctuations in the relative number of skilled workers available to meet the demands of the sector are highlighted. These factors include erratic promotion of apprenticeship schemes, the poor public image of the industry and an emphasis on the intellectual knowledge society to the detriment of industry training. A number of possible solutions to the skills shortage are analysed. The paper concludes that industry and government need to be proactive and decouple the training of a skilled workforce from industry boom and bust cycles.

Keywords: construction, skills, economy, training

Introduction

A skills shortage in New Zealand's building and construction industry first emerged in the late 1990s as the New Zealand economy flourished and the industry was stretched beyond capacity. Construction sector activity has traditionally followed a cycle closely related to the strength of the local economy, which in turn mirrors global economic trends. In the current upturn in construction activity half of all construction companies are reporting difficulties in finding skilled labour and one in three businesses say staff shortage is a severe constraint on further expansion – a thirty year high. The shortages are increasing building prices and threatening to seriously undermine the economic growth of the country. The increasingly mobile and rapidly ageing population will make the situation more difficult to control in future. The poor public image of the building industry has the potential to aggravate any shortage that occurs by making recruitment of new employees difficult.

It is not a fleeting trend that will disappear as the industry becomes more successful or trains more people. The past reasons for the situation must be clearly defined and noted to avoid similar errors in the future, and to guide the conception of a solution to the present crisis.

Industry Overview

The New Zealand Building and Construction Industry is dominated by small to medium enterprises. Most structures are constructed by self-employed builders and specialist sub-contractors who work in small businesses. Individual houses are the main residential buildings constructed, but there are also increasing numbers of medium to large residential buildings such as apartment blocks and townhouses. The building and construction industry employed 115 000 people at the end of April 2004 – representing 7% of all people employed in New Zealand. The industry also indirectly employs thousands of people in support jobs related to manufacturing, material supplies and transport services. The skill shortages are reported to be universal across the industry, affecting all levels of the supply chain.

When viewed from a short-term perspective, the industry appears to be very attractive. The economy is booming, jobs are in abundance and the skills shortage means clients are willing to pay well in order to secure the services of contractors. In the long term the demand for labour may remain at its current boom level, since, with the ageing population and declining workforce, the size of the building and construction labour sector will also decrease, yet have to complete the same amount of work. However, this assumes that work levels will remain high and a more likely scenario, if the industry continues to remain reliant on the economy, is that the amount of work will inevitably decrease and poor job prospects will return.

Causes of the skills shortage

Most respondents to a survey perceived the image of the industry to be poor, aggravating the skills shortage by making recruiting difficult. Reasons given for the poor public image were low job security, dangerous work (an average of 13 fatalities per year is one of the highest of any industry), low levels of pay, and the myth that the occupation needs little unintelligence.

A strong link between the success of the economy, capital works and apprenticeship training numbers demonstrates a reactive approach of industry training to the economy, which appears logical in the short-term, but can result in long-term difficulties. The training delay in the system ultimately creates surpluses and shortages with associated consequences.

Improving the image is essentially about increasing the value the industry has for its people. This is directly related to the value that society as a whole has for the profession and the workers that maintain it. The reality is that skilled labourers are not expendable and to retain them in the industry or country, a high level of job security, health and safety practices and incentives need to be nurtured. Common myths, such as a career in the industry being hard, manual labour requiring little intellectual ability, must be dispelled if a trades career is to be held in high regard by society. A job in the industry is also not especially attractive to certain groups, such as females, which will become an essential area of improvement with the ageing population of future years. Overall, a more active and concentrated approach must be taken by industry to promote the benefits of a building career and raise the esteem in which it is held by the public.

Potential solutions to the skills shortage

A number of possible solutions to the skills shortage in New Zealand are available, including immigration, attracting underrepresented groups, continual learning, multi-skilling, increasing automation and lessening the 'boom and bust' nature of the industry. No definite conclusion can be proposed as to the best solution but the main message is that no one alternative should be relied upon. The situation is complex, and hence the solution will require a combination of all options.

Immigration - offers access to talent and skills that are not available in New Zealand and hence has the potential to lessen the negative impacts in times of skills shortage. There are two ways in which immigration can be used to lessen the severity of the shortage.

Allowing more people into the country in response to a skills shortage ('reactive' approach)

Pre-empting a rise in the economy based on past trends and allowing more people into the country to avoid a skills shortage ('proactive' approach)

Attracting underrepresented groups - in response to the current skills shortage across all areas government is encouraging employers to take on workers they may have previously overlooked. This involves searching beyond traditional sources of talent and encouraging diversity in the workplace. It highlights such ideas as gender and ethnic variety and hiring people with disabilities.

Continual learning - has potential to reduce the skills shortages of the future through enhancing the skills of each individual in the industry. Continual learning encourages every person to work to his or her full potential, developing the skill base without increasing the working population.

Break economic link - apprenticeships should aim to become more independent from the oscillating economy – involving proactive rather than reactive thinking. This could entail a training mechanism that enables a constant level of training regardless of economic conditions and ensures there are enough people in the workforce at any one time.

Conclusions

The current skills shortage in the New Zealand Building and Construction Industry threatens to seriously undermine the potential economic and innovative growth of the profession. To prevent this, the industry needs to actively invest in finding a solution. Instead of deciding whether the government or industry is to blame and who should provide funding and how much, the focus should turn to solving the issue in an equitable and strategic way. This no-blame culture in which all sections of the industry and relevant government departments have responsibility for the outcome will ultimately create a more productive and effective range of solutions to the crisis. The three key concepts that have emerged from this study to remember in developing these solutions are collaboration, value for people and proactive-thinking.

Products and services: Is there a case for integrated solutions in construction?

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Leading firms throughout the construction sector are increasingly emphasising the satisfaction of clients' needs through service provision. This follows developments in other sectors, such as aerospace, defence, healthcare and mechanical engineering where firms are frequently required to compete on the basis of complex bundles of products and associated through-life support services. This paper reports on an ongoing research project initiated to investigate the cross-sectoral shift from product delivery to service provision in the UK. Of particular interest is the extent to which theories derived from the manufacturing sectors are applicable in construction. Integrated solutions that combine built facilities with aspects of service provision have a long history in the construction sector. The extent to which the currently espoused shift to services represents a radically new business model can therefore be contested. Nevertheless, the narrative of integrated solutions goes some way towards providing a legitimising discourse for construction firms involved in PPP/PFI. But in practice, the opportunities for integrated solutions are dissipated by the fragmented nature of the contractual arrangement whereby different operating companies continue to pursue bounded interests.

Key words: Integrated solutions, service provision, transition, PFI

Introduction

The provision of additional services to accompany the sale of products is becoming increasingly central to the emerging business strategies of manufacturing companies. The purpose of this paper is to ascertain the extent to which the trend towards extended service offerings applies to the construction sector. To this end, the arguments in support of product-service business models in the mainstream literature are reviewed and critiqued. This is followed by an evaluation of the concept of 'integrated solutions' in terms of its underlying assumptions. An historical perspective is then adopted to establish whether or not the integrated solutions are new in construction. In this respect, consideration is given to a range of established procurement approaches. Particular interest is given to the implications of a change in emphasis in procurement arrangements, especially the Private Finance Initiative (PFI), which has grown into a significant market in the UK. The paper finishes by comparing emerging findings from a construction firm case study with the business strategy literature.

Integration of products and services

There are seemingly compelling arguments for product providers to diversify into services. As stated by Oliva and Kallenberg [1] the "'management literature' is almost unanimous in suggesting to product manufacturers to integrate services into their core product offerings". The literature frequently talks in terms of a 'shift', thus implying a dichotomy between the old mode of working and the new one. Others refer to a transition along a continuum spanning between two extremes. In its simplest and cleanest form such a continuum would have pure product manufacturers at the one extreme and specialist service providers on the other. However, the reality is much more complex. Practicing managers are understandably attracted to the possibility of benchmarking themselves against other firms in terms of where in the 'transition' they are. However, such aspirations invariably flounder on the fact that firms frequently comprise multiple business units, each of which have very different orientations towards products and services. The extent to which any business unit is orientated towards services will invariably be contested internally. Strategic aspirations and operational realities are frequently conflated to such an extent that benchmarking exercises against 'objective' continua become highly politicised as interest groups compete for power and resources.

Unravelling the arguments for integrated solutions

For product-focused organisations to develop an integrated solutions strategy is by no means a trivial task and is likely to have profound implications. Foote et al. [2] recognise that different business units have vested interests in existing ways of working, and any change initiative will inevitably upsets the status quo. Product-focused business units frequently lose status and resources to the newly formed customer-facing units. Such comments evoke political models of organisation whereby different interest groups compete for power and resources. Indeed, rather than seeing intra-organisational politics as a 'barrier' that has to be overcome, it is possible to see the 'shift to integrated solutions' as a discursive resource that is mobilised as part of ongoing process through which management ideas are continuously contested. In this respect, the storyline in favour of 'integrated solutions' follows the broad script of previous management fashions such as TQM, BPR and lean production. This is not to say that such ideas do not shape the reality of organisations, but rather to focus attention on the processes through such ideas are advocated and interpreted within the context of complex pluralistic organisations. The argument promoted in support of integrated solutions echoes those made in support of previous 'radical' business solutions. It also accords with the universal applicability model of how new ideas are absorbed into organisations, i.e. the argument is that the shift to integrated solutions is an economic imperative and that firms therefore have little choice. But the broader literature on the diffusion of management ideas discredits this 'adopt or die' storyline and emphasises the way in which new management ideas are subject to localised appropriation. Any notion of a 'radical reorientation' in operating practices are considered infeasible given the constraints within which managers operate. Change processes are much more incremental and uncertain and frequently involve a certain degree of lip-service being given to ideas such as 'integrated solutions' whilst continuing with established practices. Of further importance is the recognition that any espoused transition would comprise both rhetorical and substantive components. Indeed, in many cases the former may well be more prevalent than the latter.

Relating the business strategy literature to the construction context

It must be recognised that construction has always shared an important characteristic with the service sector, namely that construction work takes place at the point of purchase. This is in contrast to the traditional practice within manufacturing firms whereby goods are fabricated before being moved to a sales location and then sold to the customer. 'Customer pull' whereby goods are only manufactured in response to customer orders is undoubtedly a growing trend with the manufacturing sector, but this can hardly be constituted as new for those working in construction. The notion of a shift from 'product delivery' to 'service provision' rather assumes that construction is primarily a product-producing industry. The fact that construction invariably takes place at the point of delivery explains why the sector is frequently referred to as a provider of 'construction services'. Therefore, in the case of construction, the distinction between product delivery and service provision is even more unclear than it is in manufacturing More pertinent within the construction sector are changing procurement arrangements that seek to combine responsibility for the provision of buildings with aspects of facilities management over extended life cycles. Of prime importance in this respect has been the advent of the Private Finance Initiative (PFI).

Conclusions

There are many reasons why a firm would want to undertake a transition from product delivery to also providing additional services. Such a change could be mobilised as a means of securing future business, or it could be initiated by a change in public procurement strategy. In the construction sector, the development of the PFI market has had a significant impact on how many companies win work. However, the extent to which construction operating companies have become more service-oriented is debatable. It is further necessary to distinguish between rhetorical and substantives shifts towards service provision. Given that the shift towards service provision is at least in part a management fashion it can be expected that some firms give lip-service to the idea with little reorientation in how they operate. But there are continued difficulties in conceptualising 'firms' as single entities. PFI projects are not delivered by single 'integrated' firms, but by temporary alliances between different organisations. Even when two companies are part of the same group, there is little reason to assume that they share a unitary set of interests. Perhaps of greater significance is the shift in how risks are perceived and shared between the parties. Risk management has always been central to the construction sector's industry recipe, and PFI contracts require firms to invest in the development of new capabilities to deal with these added risks. In the final analysis, issues of risk are paramount.

References

[1] Oliva, R. and Kallenberg, R. (2003). Managing the transition from products to services. *International Journal of Service Industry Management*, 14(2), 160-172.

[2] Foote, N.W., Galbraith, J., Hope, Q. and Miller, D. (2001). Making solutions the answer. *The McKinsey Quarterly*, 2001 Issue 3, 84-9

The role of privatisation

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Over time there have been changing attitudes towards state ownership of the means of production. For the past two to three decades the trend has been towards privatisation. This paper explores the reasons for this and uses the experiences of Trinidad and Tobago to illustrated the situation. The changes in ownership affect the construction industry because they reflect the changes in the principal clients of the industry.

Keywords: Privatisation, policy, monopoly, competition, economic efficiency

Introduction

Up until the late-1970s most countries operated with a significant degree of state ownership of business. Governments wanted to plan national development and be able to control its implementation.

The Government of Trinidad & Tobago (GoTT) was typical of Small Island Developing States (SIDS) that saw state participation in industry as key to economic development. In 1969 the GoTT set out its strategy for state participation in the economy, reserving the right to enter into any productive activity that it felt was in the public interest. By the early 1980s the government was involved in some 65 State Owned Enterprises (SOEs).

A 'structural adjustment' to the economy in the late 1980s resulted in a reduction in the scale of the public sector, which included the divestment of thirteen SOEs into private ownership. Poor performance of SOEs was largely due to the lack of management incentives and motivation [1], and also politically motivated intervention in their decision making, and hiring practices.

Scale of privatisation

Between 1990 and 1999, there was a spate of privatisations especially in the non-OECD countries, with 'tens of thousands of enterprises sold and roughly $250 billion in revenues raised' [2]. During this period, private finance focused on infrastructure developments – such as electricity, water, transportation, and telecommunication facilities in the developing world [1] - that became attractive in the absence of better investment prospects elsewhere.

By region, Latin America and the Caribbean accounted for almost 70 percent of the proceeds of privatisation and merger and acquisition deals with the largest contributions coming from the sale of infrastructure and energy firms in Argentina, Mexico, and Brazil. Up until the 1990s, Trinidad & Tobago (T&T) had a large proportion of its economy owned and operated by the public sector including all of the basic utilities; electricity generation and distribution, telecommunications, water and sewerage, the transportation infrastructure, including airports and harbours, the oil and gas industries, the postal service, the national quarries, teak forestry, the iron and steel plant and numerous other incongruities like a paper and packaging company. Over the two decades to the present, most of these have been either wholly or partially privatised.

Objectives of privatisation

The primary objective of privatisation is usually to improve economic efficiency – which includes an expectation that waste will be reduced, that quality will be improved. Governments also often seek to promote their social objectives through privatisation, such as improving the delivery of services to remote and unprofitable customers, and raising employment levels and public finances.

Privatisation can be achieved in a number of different ways from sale through public offering or to selected individuals or institutions, through to encouragement of competition or 'vertical separation' of an enterprise into two distinct parts –one of which can be supplied competitively (e.g. electricity generation), while the other is supplied monopolistically (e.g. electricity distribution).

Competition or ownership?

Iron and Steel

The Iron and Steel Company of T&T (ISCOTT) was completed as an integrated mini-mill in 1981. It was a core industry in the government's strategy of developing a heavy industry base around which it was hoped a downstream industry would develop. The company ran at a loss under state ownership until Caribbean Ispat Ltd. took a lease in 1989 with the option to purchase, which it did in 1994. The facility, under private ownership, is now a large earner of foreign exchange.

Telecomminications

The telephone network in Trinidad and Tobago was developed privately from the mid-1930's until 1960 when the Government purchased the company. In 1968, the Government went into an equal partnership with a private firm until 1973 when it took complete control again. In 1991 the GoTT again went into a partnership (this time with Cable and Wireless) with the GoTT as majority shareholder in the new company - Telecommunications Services of T&T (TSTT).

Electricity

In 1886 the first power station in T&T was builr privately to cater for a new tram service. This changed hands a few times before the Government nationalised the company in 1933 as the Trinidad and Tobago Electricity Commission (T&TEC). In 1994, the company was split into its distribution side and the Power Generation Company of Trinidad and Tobago (PowerGen). T&TEC has the kept majority holding in PowerGen (51%).

Oil & Gas

Oil production was historically controlled by large foreign companies, such as Shell, British Petroleum, Texaco, and Amoco. By the late 1980s, however, the government had purchased all foreign operations except Amoco. Even so, Amoco still produced over 50 percent of the country's oil, possessed most of the newer and more productive oil fields, and controlled over 70 percent of the natural gas reserves. In the late 1980s, the government again allowed foreign oil companies to become involved with the exploration and production of oil and gas with firms like British Gas and BHP Billiton now involved.

Other State Owned Enterprises (SOEs)

In a number of instances SOEs had been so badly run that they had ceased operations altogether and laid off their workforce before they were privatised. This meant that the new company was an entirely new enterprise with a 'clean sheet' as far as responsibilities towards previous employees were concerned. In these instances single companies took over the operations of the erstwhile SOEs. In other cases, private and institutional investors took over the enterprises through the purchase of shares, and in two special cases the government sought out a significant strategic investor to take over a significant share of a failing SOE.

The Utilities

In Developing Countries like Trinidad & Tobago a large proportion of state spending is channeled through the utilites, especially capital investment for the extension of coverage of their networks.

T&T has, for example:

-Brought in firms to access their *managerial expertise* in an attempt to improve delivery. Severn Trent and New Zealand Post have both found it difficult to meet their targets. [3]

-The *partial privatisation* of the enterprise. The Electricity Commission has privatised the generation side of the business, while the distribution side remains in state ownership.

-The *deregulation and restriction of state-provided services* to encourage private participation – the public transport service and the ports

Construction

The ownership of enterprises is significant to the construction industry because this determines who the principal client will be. Extended public ownership in countries like Trinidad & Tobago, means that the construction industry is dependent on government as the main source of work. This makes it important to maintain political favour otherwise it could be difficult to obtain work. The changing times have meant the privatisation of many enterprises and the tendency to contract out work that would previously have been done by *force account.* More recently, there have been further dramatic changes. Together with the high private sector work load, there is now also a very rapidly increasing public sector workload again. The GoTT has established new SOEs to undertake this work, which avoid the transparency that other public sector organisations are obliged to display in their operations. There is serious concern over these companies because they do not follow the prescribed procedures of other public scetor agencies, and because they are not accountable to anyone except cabinet.

References

[1] International Monetary Fund (2005a), *Trinidad and Tobago: 2004 Article IV Consultation*, IMF Country Report No. 05/4, Washington, D.C.

[2] Kikeri, Sunitra & John Nellis, 1992. *An Assessment of Privatization.* World Bank Research Observer, Vol. 19, no. 1, Washington, D.C.

[3] Trinidad Guardian, (2004) *Editorial*, 19th March.

The competitiveness of the CARIFORUM construction sector

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The European Commission (EC) has initiated a number of Economic Partnership Agreements (EPAs) within which it wants to include trade in services under terms that are fair to both sides. The countries of Cariforum have joined together for the purpose of negotiations, and an early focus has been placed on the construction market. The focus is on the competitiveness of the sector in Cariforum to try to establish what would enable it to be better able to compete internationally and strengthen the domestic economies. The industry was found to be very variable across the contries involved but to generally be competitive for medium to smaller scale projects. .

Keywords: CARIFORUM, competitiveness, EPA, contract awards, project size

Introduction

The fifteen countries that make up the Caribbean Forum of ACP States (Cariforum) are faced with two major trade concerns currently, the first being their desire to form a free trade association amongst themselves and the second being involvement in a free trade area of the Americas. One of the key issues in both is the need for an effective competition policy. This is very relevant to the construction sector because of the desire of the Developed Countries to gain access to new markets like those in the Caribbean.

It is the larger projects that are the focus because of the greater potential they offer. The majority of these projects, however, have little technical complexity, but they have high financial and human resource demands. There are few local firms that are large enough to deal with such projects, which has meant that they either have to get into joint ventures with foreign firms or miss out. It also means that local firms are unlikely to be able to compete on projects abroad, for both scale and resource reasons. As a result, the local construction industry stands to gain very little from ‘free trade’.

The largest firms in the English-speaking Caribbean are from Trinidad & Tobago (T&T), Barbados and Jamaica, but they are relatively small by international standards. For largely cultural reasons they rarely compete directly in one another’s countries, nor do they seek work in Spanish or French speaking countries of the Caribbean.

Although there is plenty of work in the region currently, local firms complain [1] that, when they are in need of work, they are often excluded from even bidding on local projects by excessive prequalification requirements. They are also inhibited by the difficulty and expense incurred in accessing finance for working capital, bonding, performance guarantees, insurance and legal services for offshore projects. The lack of Export Credit Guarantees for local contractors working abroad is also a source of discontent.

Problems of the industry

The local industry believes that clients and funding agencies prefer foreign firms and express and implement that preference through exclusionary prequalification terms. Such terms may include the firm’s recent history on similar large jobs, or a record of high dollar values of turnover, for example. Given the scale and fragility of most of the economies of the Caribbean, it is virtually impossible for local firms to score highly on such terms.

There seems little reason why large projects are made so big. A highway extension project, for example, may be too large for a local firm. The main problem is size rather than technical deficiencies. A single project may be more convenient in administrative terms, and have less ‘interfacing’ problems, but careful ‘packaging’ could easily overcome such issues.

The issue of the size has a number of parameters such as finance, risk, and resource availability. Finance is a problem, both in terms of the scale of the working capital required, and the high local interest rates Risk is an issue because of the scale of the ‘exposure’ and of bonding requirements [2] in relation to the size of the firm. The availability of sufficient skilled and experienced staff is a major resource constraint.

Significant changes

There have been recent changes to procurement in the construction industry in the region, particularly the use of fixed price contracts with incomplete designs and unreliable Bills of Quantities. This increases the risk faced by the contractor and the risk premium for the client.

In addition, a new standard form of contract document is being being used, with a modified form of FIDIC replacing the previous standards.

The construction projects have also tended to become more confrontational, because the client's aspirations for a fixed, minimum price contract conflicts with the contractor's need to find ways of winning work, dealing with risk, and 'squeezing a profit' out of the job.

Another concern is the high cost of bidding with eight tenders often required on major projects. This is amplified by the belief that some overseas contractors bid at or below cost in order to gain market entry. This is a form of 'dumping' and is illegal

Discussion and conclusions

It is becoming apparent that it is not really realistic to treat with a 'Caribbean construction sector', because the dissimilarities are so much more profound than any similarities that can be identified. Nevertheless, the region is attempting to formalise its market linkages through trade liberalisation, and in the EPA negotiations wishes to deal with industrial sectors on a CARIFORUM-wide basis, so it is impossible to avoid some degree of generalisation.

That having been said, it is unlikely that construction firms from the region have much to benefit from freer trade, as the non-tariff barriers that exist on entry into US or European markets will effectively prevent even those few firms that might be able to bid for work there, from doing so. Thus, 'global' competitiveness is meaningless to the typical construction firm in the region.

Competition policy, however, almost certainly has an important role to play, especially with regard to public sector expenditures, and the privatisation of public utilities. In addition, the government should use 'set-asides' – projects up to a certain cost limit that are reserved for local construction firms.

Finally it must be accepted that the competitiveness of the construction sector in the Caribbean can be improved particularly by an increased focus on quality, which itself will require improved education and training and higher skill levels throughout the industry. [3][4]

References

[1] Lewis, T.M. (2002) *Report On Caricom Construction & Installation Services Sector: Elements For Competitive Strategies*, RNM, Kingston, Jamaica

[2] Taylor, Garth (2003) *Proposals For A Regional Joing Bidding Mechanism And Joint Bonding Facility*, CRNM Issues Paper, available at http://www.crnm.org/documents/studies.htm

[3] European Commission (2002b), *Communication on the Competitiveness of the European Construction Industry,* see http://europa.eu.int/comm/enterprise/construction/compcom/compcom.htm

[4] Janssen, Jorn (2000), The European construction industry and its competitiveness: a construct of the European Commission, *Construction Management and Economics 18, 711-720*

Slimbouwen, a strategy for efficient and sustainable building innovation

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Slimbouwen® (SLIM in Dutch stands for both smart and lean) starts from the appointment that the traditional way of building does not fit the today's requirements anymore. Building does substantially affect the environment in many ways and the building process has become quite complex. In the last century step by step services were added to the already known building structure, without re-evaluating the building tradition. Slimbouwen is based on a skeleton structure and the separation of services from the building structure.The separation of services facilitates a simplification of the process. Slimbouwen is a new building approach but also a source for research in the frame of 'product development'.

Keywords: strategy, sustainability, efficiency, innovation, product development.

1. Innovation by addition

The traditional building process is also nowadays strongly based on ancient lines. Stacking, timber frame and even pouring concrete was already applied in the Romen era and to some extend even before. Surely there was innovation. Especially in the past century the quality level increased substantially. Sound insulation and fire protection were improved, energy consumption for heating houses was reduced, communication techniques and domotics were introduced, etc. Only all this innovation has not caused a fundamental other building approach. We maintained the existing building technique and we only added lots of technology on a component level. That is what is meant by 'Innovation by addition'. Adding to the existing creates inefficiency at the end and that is exactly what happened in the construction industry.
The inefficiency is caused by adding especially installations and services during the last century. In 1900 the installation technique was limited to a sewerage system, water supply and a chimney. Now, 100 years later, the installation technique is about 30-40% of the total building budget. For vertical transport shafts were added to the building. For the horizontal transport (piping and wiring) there was hardly any solution but to hung it under the floor.Electrical services and water supply were fixed on walls.
In the second half of the 20e century, services in sight were not accepted any longer. Nowadays we use to hide them in walls in milled chases, being covered afterwards or we hide them into poured concrete constructions. We still hang them under floors covering it with suspended ceilings. In this case therefore even addition on addition.Through this way of stacked innovation the interweaving of services with the building parts has become very high.
This is an important conclusion since it has caused an inefficient building process. For one thing, the consequence is that the finishing process has become very complicated and is carried out by many disciplines with a high rate of mutual interdependency.
All in all it is remarkable that the building method as a whole never was rethought.

2. Eye openers

A number of eye-openers show that the traditional way of building in the contemporary context is no longer tenable. The statements are based on the Dutch situation, however the effect is quite similar in other Western and industrialized countries. Some examples:

1. For the realization of 1 m^2 net floor surface 1,000 up to 1,500 kg of building material is applied. A mobile home weighs 80-100 kg per m^2;
2. The building industry is responsible for 35% of the total waste production.
3. 25% of all road transport of goods is building related;
4. The production of building materials represent 8-10% of the total energy consumption. The energy used in buildings represents about 33% of the national consumption;
5. 25% of a building volume is packaging. Customers rent or buy gross volume of which about 25% is taken in by building structures or hollow cores.
6. The price of houses is compared to consumer goods considerably risen.
7. Buildings are built with a technical life span of 100 years or more, but often they are demolished already within 35 years.
8. The traditional building process requires a lot of building site personnel and expertise that is not sufficiently available.
9. In the building industry (contractors) average cost of failure are approx. 10% of the turn over. Profits are in the range of only 1-2%.

The eye-openers can be considered as symptoms that support the theorem that rethinking the building industry is unavoidable.

3. Slimbouwen

Slimbouwen [1] is to be considered as a strategy that reacts to the problems as described. Slimbouwen will result in concepts and products that facilitate its realization and in fact it already has generated some new products. In itself Slimbouwen is certainly not a building system. It is more like a shareware platform.
Slimbouwen in this function offers also a basis for development strategy for the industry and by this to provide for an infrastructure and coherence to the fragmented development efforts.
One of the main objectives is to rearrange the building process from an on site parallel process into a serial process existing of only a few main steps with a minimum of interdependency.
A sequential process containing limited number of major sub activities, can only be obtained by a separation of services from the rest of the process. In the traditional process the services are interwoven with almost all building parts and in a new approach this has to be avoided. Only than it will be possible to divide the building process into a limited number of sub processes with a low interdependency rate.
Each main participant is responsible for preparation, production, mounting, guaranties, etc. for the total sub system. This is similar to other industrial branches.
As a breakthrough development a team of A+ created the so called Infra+ concept (fig 1). Infra+ is a hollow core floor system suitable for horizontal distribution and access of services in the structural zone (no additional space upon or beneath the floor required). After positioning the services the floor is covered on the upper side. Meanwhile this product has found already many application and is by the success already followed by various interpretations by other producers. Infra+ is an example of product development that was initiated by the Slimbouwen strategy.

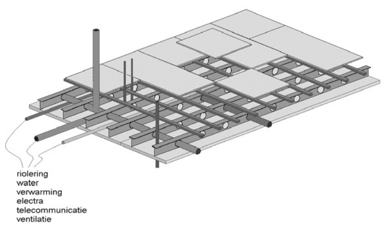

Figure 1: The infra+ floor concept

The natural solution for the sequential building process (fig 2) is a division in:
- Foundation, skeleton and floors;
- Skin (Outer walls + roof);
- Services (vertical through shafts, horizontally through hollow floors);
- Infill (top floor and partition walls)

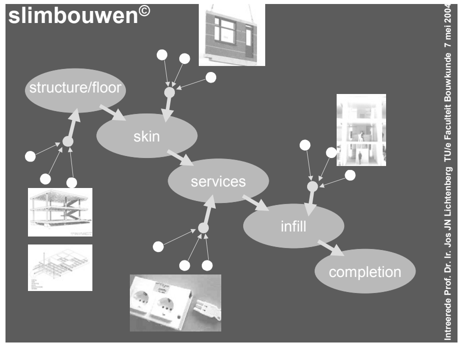

Figure 2: Sequential building process)

The above strongly emphasized on the process aspects of the Slimbouwen concept. Efficiency brings of course mayor economical advantages.
A second value of the concept is the flexibility which enables owners to adapt buildings to users and market developments. The division of services is a basis for obtaining flexibility and adaptability.
A third aim in relation to Slimbouwen is the reduction of materials, volume and of the environmental burdon, a.o. energy, transport, emissions and waste.

4. Bridging science and practice

One of the important aspects of Slimbouwen is also that it acts as a language between practice and science. And by that to a better focussing of research subjects. The research in the frame of Slimbouwen in the future will focus on the consequences and possibilities for both new product and market development. As a result of the communication between market and university concrete research topics have been identified.

References

[1] Lichtenberg J.J.N. (2005) *Slimbouwen* Boxtel: Æneas

Exploitative innovation in a large professional service firm

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The balance and synchronisation of exploration and exploitative innovation is fundamental to the competitive success of firms in dynamic environments. While the importance of pursuing both types of innovation has often been highlighted in the general management literature, what is less clear is that the role of structure capital in exploitative innovation in a construction professional service firm context. The aim of this paper is to explore the development and implementation of an exploitative innovation - a document management intranet system - within a large, multi-disciplinery professional service firm in a construction context. The interim research findings reveal that structure capital was particularly pertinent for exploitative innovation success within a large professional service firm as it was seen as the principal means by which outcomes of best practice can be captured, amplified and shared across the organisation and across different projects.

Keywords: Professional service firms, exploitative innovation, explorative innovation.

1. Introduction

Successful innovation has been described as being the principal means to bring about improvement in the UK construction industry performance. Exploration and exploitation [1] is a useful construct to differentiate the loci of innovation activity. March [1] argues that 'exploitative capabilities' are those resources utilised to improve organisational efficiency to generate short term competitive advantage; whilst 'explorative capabilities' create and use new resources and capabilities to improve organisational effectiveness to generate *sustainable* competitive advantage. Lu and Sexton [2], in a construction context, have found that the key distinctive feature of exploitative innovation (compared to explorative innovation) is structure capital. The aim of this paper is to use Lu and Sexton's [2] framework of 'knowledge-based innovation model' to consider the role of structure capital in exploitative innovation within a large construction professional service firm (PSF).

2. Key issues from the literature

It has been recognised that the challenge for organisations to create sustainable competitive advantage in rapidly changing and competitive environments is for resources to be integrated, co-ordinated and deployed as 'distinctive capabilities' [3]. This constant development of 'distinctive capabilities' in a dynamic environment is labelled as 'dynamic capability' [3]. The work of March [1] provides theoretical guidance on this challenge through the distinction between exploitative and explorative capabilities. The notion of balance between exploration and exploitation has emerged as an underlying theme in innovation research. Benner and Tushman [4], for example, argue that 'exploratory innovations' are designed to meet the needs of emerging customers or markets; whilst 'exploitative innovations' are designed to meet the needs of existing customer. Further, various literatures have agreed that balancing and synchronising exploration and exploitative innovation is fundamental to the competitive success of firms in dynamic environments [5]. This view is very much an extension of similar discussions focusing on the appropriate balance between explorative and exploitative innovation in large PSFs [5] and small construction PSFs [2].

The need for an appropriate balance between explorative and exploitative innovation has been developed in a construction context by Lu and Sexton [2] in their conceptualisation of a successful innovating firm. They argue that temporal considerations are essential to the development and maintenance of an appropriate, dynamic balance. According to Lu and Sexton [2] the firm's short-term success is driven to a significant degree by 'explorative' innovation and long-term success by 'exploitative' innovation. More specifically, they observe that the key distinctive feature of exploitative innovation (compared to explorative innovation) is that new phenomena, systems or structures are embedded in organisational structures (labelled as structure capital in this research, see Section 4) of the firm. The many studies into the relationship between structure capital (SC) and innovation, however, have produced inconsistent findings. On the one hand, innovation and SC are argued to be complementary to each other. Zollo and Winter [6], for example, observe that written rules and procedures might help units to facilitate the replication and diffusion of an exploratory innovation. On the other hand, opposite arguments have also been suggested that organic system appear in a more suitable organisational context for innovation than mechanistic systems. Arias-Aramda *et al*. [7], for example, argue that "service standardisation clearly affects in a negative way the degree of innovation." The central argument being made here is that while the importance of pursuing both types of innovation has often been highlighted, what is less clear is that the role of structure capital in innovation research.

3. Research methodology

The empirical data for this paper is coming from an ongoing single case study which is using action research to bring about a successful innovation within the company setting. The case study firm is one of the UK's leading multi-disciplinary property firms. The business unit, labelled hereafter as Unit A for confidentiality reasons, is a broad-based building construction service provider having 12 offices in various cities in the UK. The action research intervention has focused around the development and implementation of a standard document management intranet system, in accordance with ISO 9001:2000 requirements, into Unit A.

4. Interim conclusions

A number of tentative interim conclusions can be drawn. First, the research results reveal that the document management framework (work standardisation, formalisation) provided the basis of accumulating best practices in the organisation. It was found that the 'the lesson learned' or 'best practice' in Unit A did not have sufficient demonstrable benefit or momentum to become embedded in SC; rather, the experiential learning stayed with the individual in a tacit form. By embedding knowledge and experience in routines, the knowledge will remain with the company when a professional leaves the company. Second, the research findings confirm that this system provides a critical roadmap of services which supported purposeful knowledge interaction activities. The identification of key contacts for each service, for example, provided an access to valuable source of information. Finally, the research results identify that the intranet system is a key mechanism to effectively encourage and support Unit A staff across different levels and different regional offices to share their knowledge and experience. When documents in an electronic form and on-line, it ensures that individuals receive the most recent version of documents, but do not waste time looking for them. Unit A staff, for example, was reviewing this system through the company intranet. In summary, the research findings confirm that SC plays a significant and positive role in the development of exploitative innovation activities. SC was seen as the principal means by which outcomes of best practice can be captured, amplified and shared across the organisation and across different projects.

This ongoing action research project is currently in the action taking phase – testing document management intranet system. Further research will focus on how exploitative innovation influences organisational performance; in particular, the use and renewal of the content of the document management intranet system over time.

References

[1] March, J.G. (1991) Exploration and Exploitation in Organizational Learning, *Organization Science*, 2(1), February, 71-87.

[2] Lu, S. and Sexton, M. (forthcoming) A Theory of Innovation in Small Construction Knowledge-Intensive Professional Service Firms: A Case Study of An Architectural Practice, *Construction Management and Economics*.

[3] Teece, D.J., Pisano, G., and Shuen, A. (1997) Dynamic Capabilities and Strategic Management, *Resources, Firms and Strategies*, N.J. Foss, Eds., Oxford University Press, New York, NY. 268-285.

[4] Benner, M.J. and Tushman, M.L. (2003) Exploitation, Exploration, and Process Management: The Productive Dilemma Revisited, *Academy of Management Review*, 28, 238-256.

[5] Justin, J., Van Den Bosch, F.A.J. and Volberda, H.W. (2006) Exploratory Innovation, Exploitative Innovation and Performance: Effects of Organizational Antecedents and Environmental Moderators, *Management Science*, Available at SSRN: http://ssrn.com/abstract=884160

[6] Zollo, M.M. and Winter, S.G. (2002) Deliberate Learning and the Evolution of Dynamic Capabilities, *Organization Science*, 13, 339-351.

[7] Arias-Aranda, D., Minguela-Rata, B. and Rodríguez-Duarte, A. (2001) Innovation and Firm Size: An Empirical Study for Spanish Engineering Consulting Companies, *European Journal of Innovation Management*, 4(3), 133-141.

Cooperation network “lifecycle-oriented buildings” – potential success and failure factors

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While construction companies seek for new possibilities of differentiation, institutional clients demand the paradigm shift towards a focus on the costs of a complete life-cycle and away from a focus on the initial investment costs. Within the scope of the development of a new cooperative business model for life-cycle service provisions (LCSP), market success factors for such LCSPs have been deduced, using the hypothetico-deductive research method. The hypothetico-deductively determined market success factors are: information, competence, sustainability, trust, integration and standardization. This paper introduces the methodic approach and discusses the identified market success factors.

Keywords: lifecycle service provision, co-operation, business model, conflict of interest, success factor.

1. Paradigm shift in the construction industry

With the basic conditions of the Swiss construction market, the tender price becomes the decisive factor for success or failure of a construction bid. A possible way out of the price-competition for construction companies is the differentiation strategy [1] that allows for customer-oriented service provisions [2] that creates added value and that cannot be adopted easily by competitors.

Institutional clients expect the possibility to flexibly change the use of a building with reasonable efforts and low costs of operation and maintenance along with working and living conditions in compliance with social norms (optimal cost-benefit ratio). For several years now, the construction industry accordingly claims the paradigm shift to consider life-cycle costs during the tender phase for construction services rather than merely the initial investment costs.

2. Business model for life-cycle service provisions

The research at the Institute for Construction Engineering and Management (ICEM) of the ETH Zurich aims at developing a cooperative business model (fig. 1) for a strategic cooperation network in order to establish a life-cycle service provision (LCSP) for building construction. For the construction companies involved, the business model offers the possibility to lastingly disengage from the predominant pure price competition through a differentiation strategy. Clients obtain a custom-made building that is optimized to life-cycle costs and satisfies all important aspects of sustainability. Thus, the LCSP constitutes a win-win situation for all participants [3].

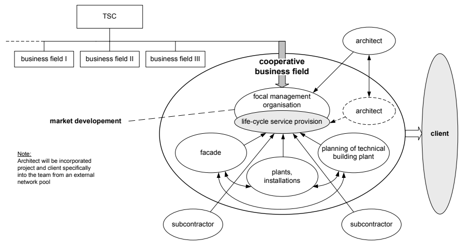

Figure 1. Cooperative business model for life-cycle service offering

3. Research methology

For the research necessary to produce this paper, the hypothetico-deductive method [4] has been applied to determine market success factors for LCSPs. During the subsequent research process, the scientific theoretical results have to be reliabilitated by empirical studies (workshops, expert interviews) [5]. With the hypothetico-deductive method, market success factors for life-cycle services have been determined following these steps (fig.2):

1) Basic evaluation of empirical data by review of literature;
2) Derivation of potential market success factors for energy-contracting services by means of deduction;
3) Structural analogy of energy-contracting services and LCSPs;
4) Transfer of market success factors for LCSPs by means of deduction.

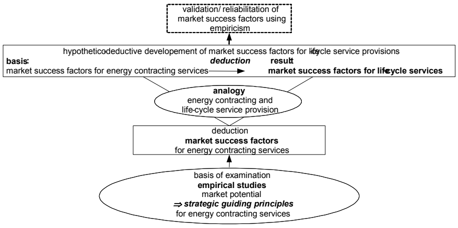

Figure 2. Hypothetico-deductive methodology to deduce market success factors for LCSPs

4. Strategic guiding principles

As a starting point for the further hypothetico-deductive research process, the following strategic guiding principles were extracted from the analyzed empirical studies:

1. A clear, trust-building message must be communicated.
2. A developing market demands the concentration of market forces.
3. There is a need for an expedient interaction in the market for energy contracting services between cooperation and competition based on division of labor.
4. Strategic alliances have to be entered.

5. Structural analogy of energy contracting and life-cycle services

The implementation strategy of the business model consisting of three levels of cooperation development which was developed in workshops including experts, was a first evidence for the analogy of both business segments, energy contracting services and life-cycle services. By considering the following parameters significant for the object of research, the structural analogy has been demonstrated:

- The targeted customer segment of both energy contracting and LCSPs are identically.
- The pursued market strategy and the competitive strategy of both business segments are extensively analogue.
- With energy contracting as well as with the intended life-cycle services, the particular service provider ought to be integrated responsibly in the life-cycle phases following the construction phase: utilization, operation, maintenance, change of usage and demolition.
- The life-cycle costs of the works of both business segments are a substantive component of the competition for construction services.
- The objects of the service provision with both forms of project delivery include all essential aspects of sustainability (environmental compatibility, profitability and social components).

6. Results - Market success factors for LCSPs

From the perspective of the strategic cooperation network (fig. 1), it is primarily the so called instrumental success factors that are of interest ([6], [7]). Instrumental success factors are configurable by the company and decisively affect the success of the company (achievement of objectives).

By applying the hypothetico-deductive research method, the existence of market success factors (information, competence, sustainability, trust, integration and standardization) for the LCSP to be developed was demonstrated. These market success factors are the basis of the further development of the LCSP and the necessary cooperative business model.

At the next stage of the research process, the hypothetico-deductive results of the presented research work ought to be reliabilitated by empirical examinations (expert interviews and workshops).

References

[1] Porter, M. E. (1992) *Wettbewerbsstrategie (Competitive strategy) Methoden zur Analyse von Branchen und Konkurrenten*, Frankfurt, Campus Verlag.
[2] Girmscheid, G. (2004) *Win-Win Situations by Partnering Project Delivery Forms - Case Studies conducted in Switzerland.* CIB World Building Congress 2004 "Building for the Future". Toronto, CIB and National Research Council of Canada.
[3] Girmscheid, G. (2004) *Projektabwicklung in der Bauwirtschaft Wege zur Win-Win-Situation für Auftraggeber und Auftragnehmer*, Berlin, Springer.
[4] Popper, K. R. (2002) *Logik der Forschung*, Mohr, Tübingen.
[5] Girmscheid, G. (2004) *Forschungsmethodik in den Baubetriebswissenschaften*, Zürich, Eigenverlag des IBB an der ETH Zürich.
[6] Borner, R. & Girmscheid, G. (2005) *Prozessmodell für projekt- und erfolgsorientiertes Wissensmanagement zur kontinuierlichen Verbesserung in Bauunternehmen*, Zürich, Vdf Hochschulverlag an der ETH Zürich.
[7] Peters, T. J. & Waterman, R. H. (2004) *In search of excellence lessons from America's best-run companies*, London, Profile Books.

Reverse logistics systems for wastes of civil construction industry

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At present, environmental legislation and consumers are becoming more and more restrictive and demanding in regards to the adequate treatment given to industrial wastes. Within this context, the application of reverse logistics concept to the Construction and Demolition Wastes (CDW) chain, which represenst a significant portion of solid urban wastes, has been seen like an organizational tool which can help companies to mitigate the environmental impacts of their activities, to increase the potential of economical and social gains and driving to the creation of new business opportunities in the productive chain of Civil Construction. Backed by a bibliographical review and personal interviews, intervening factors and benefits resulting from the application of this concept have been analyzed to contribute to for the sustainable development of the built environment.

Key-words: reverse logistics, supply chain, civil construction, constructions and demolition wastes (CDW), sustainability.

1. Introduction

Reverse logistics is a relatively new concept still evolving. Nowadays, in according to Stock [6], attributes such as "product quality, competitive prices, consistent order cycles times, on-time deliveries and low damage rates, although very important, have been seen like a standard offerings to clients". When a firm achieves acceptable standards on these attributes, other factors become differentiator in the customer's purchase decision. One of these factors is reverse logistics. It is, therefore, believed that the demand for new logistical requisites, among them the reverse logistics systems, arising from part of the clients, whether they be final consumers or businesses, will eventually affect the entire productive chain, Civil Construction included, also in developing countries. Therefore, this article intends to analyze the possibilities of such applications within the industry, and also to define the utility of the existing tools within the productive chain of Civil Construction while taking into account the specific characteristics of the sector.

2. What is the purpose of studying the application of reverse logistics in civil construction?

Beginning with definitions proposed by different authors [1] [2] [4] [5] [6], this work considers reverse logistics as : the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of application back to the point of origin or to any other point of reutilization which shows itself to be more viable; the purpose of which is to regain or create value, or still, to produce an adequate disposition for that, while taking into consideration the technical, social and economical requisites, without necessarily expressing the transference of responsibility for the flows. The study of reverse logistics, in Civil Construction sector, justifies itself and becomes effectively important due to the following principal factors [5]:

- industrial processes within the productive chain of Civil Construction generate large quantities of several industrial wastes which have caused environmental impacts;
- it is observed the launching velocity of certain, less durable, finished products and the decreasing of service life due design aspects;
- existing reverse logistics activities in the sub-chains of the sector were implemented by individual initiatives and are lacking sufficient organizational quality to be reproduced and expanded;
- sustained development of the built environment is a primary condition for planet sustainability;
- the Civil Construction industry causes environmental impacts, which has led to more restrictive legislation;
- the increasing concern of companies with corporate image.

3. Feasible aspects of reverse supply chains

Many factors can influence the economical, environmental and social feasibility of reverse supply chains. Although environmental and social feasibility involve aspects which are difficult to measure, it is essential that the more dominant aspects be taken into consideration during analysis even though such analysis may not be expressed in absolute numbers. Among the intangible aspects to be considered during feasibility analysis, it is listed some which are common in different chains and countries [5]:

- the inexistent, inefficient or economically unfeasible technology of recycling;
- the reduced availability of product/wastes;
- insufficient or non-developed market for product originated in the reverse cycle;
- the existence of oligarchies;
- the absence of constant quantity and scale;
- the uncertainty of demand: quantity, quality and delivery time;
- the uncertainty regarding the offer: existence, quantity, quality and delivery time;
- the necessity of having stocks to guarantee production;
- the necessity of “gatekeeping” and return policies;
- the decision to do a vertical structure or outsourcing activities (to make or buy);
- the analysis of cost factors to a certain feasibility;

The study by Begum [7] produced a cost-benefit model of analysis which was adapted for Brazilian reality, and used to analyze the feasibility of the reverse chain in Civil Construction. First, the reverse chain, itself, should be analyzed for economic feasibility, comparing the costs vs. benefits in creating a reverse chain. Second, analyze the feasibility of implementing a reverse chain, that is, analyze changing the present destination of post-use products to verify if creating a reverse chain is feasible or not. It must be pointed out, that sometimes, even when not economically feasible, legislation can require establishing the reverse flow chain. In this case, it should opt for the solution that is least burdensome for whoever is responsible for the goods/wastes. In the remaining cases, the strongest argument in favor of establishing a reverse flow chain is believed to be verification of a specific chain’s economic feasibility. Even though the manufacturer might not be interested in this new economic activity due to it not being part of the company’s core business, he should facilitate the founding of a reverse flow chain for his company’s product waste. Still yet, the company could offer this business to outsourcers.

4. Final considerations

It is known that construction materials possess an extensive service life. However in Civil Construction there is a recent tendency to recycle (for example, the retrofit tool) which attests to an increasing concern with reducing waste production by demolition and preserving natural sources which, if this were not the case, would certainly be used to produce new construction materials. Products not having an adequate solution for their disposal, in the not too distant future, will become uncompetitive as, disposing of the product’s waste will become an ever increasing problem for consumers. Based on the given evidence, it is believed that, the development of reverse logistics has more chances of success when the driving role is assumed by supply companies of materials, components and systems, which function as an industry and are less exposed to variables and unforeseen surprises than construction companies. The consolidation of reverse logistics has also been found to be an interdependent and on-going process between supply companies and construction companies. One-sided or scattered efforts to consolidate reverse logistics tend to produce mediocre results and consequently do little to further the propagation of this concept. The supply industries to construction should stimulate the implementation of reverse logistics systems and incentivise the creation/identification of adequate locales which can be used for the development of these alternative/complementary reverse chains to such an extent as to form a productive cluster.

References

[1] STOCK, J.R., *Development and implementation of reverse logistics programs*. Oak Brook, Illinois: Council of Logistics Management, 1998.

[2] ROGERS, D.S;TIBBEN-LEMBKE, R.S., *Going backwards:* reverse logistics trends and practices. Pittsburgh, Pennsylvania: RLEC Press, 1999.

[3] STOCK, J.R., Reverse Logistics in the Supply Chain. In: Briefing: *Global Purchasing and Supply Chain Strategies - Transport & Logistics*. 12th IFPMM World Congress, 2001 p. 44-47.

[4] FLEISCHMANN, M. *Quantitative models for reverse logistics.* Berlin, Springer, 2001. (Lecture Notes in Economics and Mathematical Systems, 501.)

[5] LEITE, P.R. *Logística reversa*: meio ambiente e competitividade. São Paulo, Prentice Hall, 2003.

[6] COUNCIL OF SUPPLY CHAIN MANAGEMENT PROFESSIONALS. Disponível em: <http://www.cscmp.org> Acesso: 22 fev 2004.

[7] BEGUM, R.A. et al. A benefit-cost analysis on the economic feasibility of construction waste minimisation: The case of Malaysia. Resources, Conservation and Recycling, Jan, 2006. 13p.

Risk issues on PPP building projects in Croatia

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Private Public Partnership (PPP) is a new type of procurement route for public buildings in Croatia. The inadequate condition of public buildings in Croatia suggests that the traditional procurement route for public and other buildings might be challenged with a new, purely contractual PPP type of procurement. This paper identifies the risk considerations for Croatian construction companies considering their involvement in Croatian PPP projects. The research was conducted through a questionnaire survey amongst Croatian private sector participants exploring whether they have an interest in PPP as well as their perception of added value that PPP projects could offer. This paper also presents preliminary results of research about the private sector perception of risks and allocation of risks on PPP building projects in Croatia.

Keywords: Public Private Partnership, Risk considerations, Allocation, Added values.

1. Introduction

A general review of the literature suggests that governments in many countries around the world are looking at ways of extending, renewing, maintaining and improving the social and economic infrastructure within their respective countries. In their role as the principal provider of social services they are coming under increasing pressure. At the same time, governments are also attempting to make better use of the available public sector funds without seeking to supplement them by increased taxation [1]. The Croatian government is encouraging, the participation of the private sector in the financing and management of infrastructure assets. This is not a new phenomenon or one that is limited to Croatia [2]. A number of governments around the world are giving the private sector a greater role in providing infrastructure services.

2. Research survey

The main goal of every PPP/PFI project is to bring added value for money and in achieving that goal the allocation of the risks is crucial [3]. In making the decision whether to procure a project traditionally or by PPP/PFI emphasis is placed on the Public Sector Comparator (PSC) as a tool that helps to show preliminary results on which procurement route, traditional or PPP, brings better value for money [4]. The parts of the PSC that will in most cases prove to be of greatest significance are the allocation of risks and the quantification of their magnitude.

Allocation of risks between the private and public sectors in PPP/PFI projects is the principal concern of the project partners. Risks can be identified using a number of "empirical" techniques such as brain storming, Delphic surveys, and checklists. Identified risks are entered into a risk register matrix and ranked according to their consequences and probability of occurrence [5]. Techniques for identifying risks are highly subjective and depend on the experience and knowledge of the estimator. Since every project is unique, so are its risks. Nevertheless, risks can generally be categorised in ways which facilitate their evaluation.

2.1. Survey description

a) The research was conducted through a questionnaire survey amongst Croatian private sector companies exploring whether they have an interest in PPP as well as their perception of the added value that PPP projects might offer.

b) Since in Croatia there is little or no understanding of PPP/PFI in general and since no projects have been procured in the building industry using this approach, the survey will reveal the perceptions of the private sector as well as their willingness to accept the new and different distribution of risks involved in PPP/PFI projects.

Questionnaires were distributed directly to the PPP/PFI team bid managers identified by the private sector companies and team managers who will be in charge of preparing the bids for the first PPP/PFI project in Croatia. Since this is a first PPP/PFI pilot Building project in Croatia it is very important to see how the private sector identifies, allocates and values the risks involved in PPP/PFI projects. For this survey, 11 questionnaires were sent to the biggest private sector building companies that have shown interest in participating in the first pilot project. Four companies responded making a response rate of 36%.

It should be noted that this survey is a part of an ongoing research project and a number of questionnaires have been sent to companies that have shown interest in participating in the new PPP/PFI pilot program initiated by the public sector. This paper presents the preliminary results of research that deals with risk issues in PPP/PFI projects in Croatia.

2.2 Presentation of survey result and discussion

The questionnaire was constructed in such way that all the participants were given a risk register. For each risk identified in the register, participants needed to rank the probability of occurrence on a scale of 1 to 5. A scale of 1 to 5 was also used to rank the impact that a risk event might have on the project goals. Finally, participants were asked to allocate the risk to the party who had most influence on the risk event, that is, to the party most suitable to carry and manage that risk, or to register that risk as shared between the private and public sectors. The risk register consisted of 44 risks that were identified through a literature review. Risks were ranked by multiplying the probability by the consequence of each risk. This way of ranking results was chosen because of its simplicity and practicality. These are preliminary results and it should be recognised that they represent the perception of risks in PPP/PFI projects in Croatia based on the views of only a small number of companies.

The lack of private sector experience in PPP/PFI projects is perceived to be the greatest of all the risks identified in the risk register. Surprisingly the private sector companies allocated that specific risk to the public sector (50%). This shows that the private sector feels that most of the responsibility for educating the private sector about PPP/PFI projects lies with the public sector. Although this risk allocation may seem to be illogical, there is a reasonable concern in the private sector about this issue. PPP/PFI is a new and unfamiliar way of procuring public buildings in Croatia. The first PPP/PFI pilot project in Croatia is at the stage of Best and Final Offers (BAFO). Since there is no history of PPP/PFI projects in the building industry in Croatia, the private building sector has no experience and no real knowledge of the expectations of the public sector. The lack of comprehensive, relevant legislation and regulatory systems for PPP/PFI in Croatia leads to considerable uncertainty.

3. Conclusions

The paper presented preliminary results of a survey ranking the identified risks and their allocation. Results demonstrate the immaturity of the PPP/PFI market in Croatia and of the level of understanding of PPP/PFI projects as a whole. The ranking and allocation of risks presented in this paper express the need for stronger involvement of the public sector in creating a more secure environment for the development of PPP/PFI projects. The results of a lack of comprehensive legislation or regulatory systems in Croatia are evident in the perception of risk consequences and probability. The biggest risk issue in PPP/PFI projects in Croatia is the lack of understanding about what the risks are and which party is in the best position to manage and therefore accept responsibility for them. Since added value for money is the main objective of PPP/PFI projects and since risk allocation is one of the key elements in bringing added-value for money in those projects, there is a great need to educate all the participants on risk issues. This paper shows the need for a holistic approach to PFI risk allocation in Croatia as well as the need to educate both public and private sectors in the basic principles of partnerships and the responsibilities that partnership brings.

References

[1] Arrowsmith, S. Ed (2000) *Public Private Partnerships & PFI*, Sweet & Maxwell, London.

[2] Marenjak S., Skendrovic V., Cengija J. (2005) Developing Public Private Partnership in Croatia, *Third International Conference on Construction in the 21st Century (CITC-III),* Advancing Engineering Management and Technology, 15-17, 383-390, Athens, September 2005.

[3] Davies P., Eustice K. (2005) *Delivering the PPP promise – A review of PPP issues and activity*, PriceWaterhouseCoopers.

[4] Akintoye, A., Beck M., Hardcastle C. (2003) Public-Private Partnerships; Managing risks and opportunities, *Blackwell Scientific Publications*, Oxford.

[5] Roumboutsos A., Anagnostopoulos K.P., Milionas A.A. (2005) Construction Sector Risk Considerations on PPP Projects in Greece, *Third International Conference on Construction in the 21st Century (CITC-III),* Advancing Engineering Management and Technology, 15-17, 190-195, Athens, September 2005.

The analysis of a new profession in the world of construction

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The process of engineering design has today undergone radical changes or is indeed in crisis. Although still conceptually valid, engineering design has been affected by the development of an enormous amount of tools. This increasingly common situation requires a new, very specific class of designer and not merely improvised inventors of ideas. This study examines novel constructions to assess their qualitative improvements and their innovation vis-à-vis consolidated building forms.

Keywords: innovative design, knowledge management, professional development.

1. Introduction

Construction design is closely linked to all the operations that come afterwards. Classical schema, from the well known process defined by Asimov [1] to the more recent one by Lawson [2], consider the creative process as the transformation of a problem into a solution. Developments in design have engendered the need for an additional engineering stage. The goal (the solution) becomes the beginning (the problem). Today, transforming a proposal into a feasible project requires a new step. However, if we consider these two stages as separate and independent, i.e. the latter can lead to a final plan regardless of the former, this questions the role of design, above all when it's very complicated to build the eccentricities of many projects.

Industry is very much aware of this turning point in time and has more or less explicitly asked architectural and town-planning design to come up with something new; it realises that this is one way to achieve better quality buildings. There's been a shift from the passive acceptance of the "expressive" creativity of architects to a market that demands "artistic" design deliver previously unthinkable qualitative improvements.

2. A comparison between two training courses for architects

Given these changes and recent experiments in design and construction, the schools of architecture began to establish new teaching models, in particular in Italy. While the responsibilities of city and land architects are rapidly changing, the faculties of architecture are becoming complicated machines to attract students and rapidly turn them into professional architects. In an attempt to make this new educational system work, unlikely combinations of traditional professional knowledge and architectural culture are either adopted or rejected. The debate focuses on how to combine specialised knowledge and art, applied science and artistic skills, in order to promote practical education. At the same time, in Europe, the different educational courses followed by Erasmus students oblige us to reflect on these educational choices. So we thought it would be useful to compare two very different approaches based on personal participation in the teaching and research programmes of the School of Architecture of the Architectural Association in London and the Faculty of Architecture in Rome University *Rome Tre*. The unit system used by the famous English school from the seventies was studied and used as a yardstick for the more recent experimental teaching method implemented by the *Roma Tre* faculty, based on the use of workshops as a way to encourage and develop ideas. The comments and graphics reported illustrate the limits and potential of both models based on these two personal experiences.

3. Development of a model to teach technological skills during training courses for architects

In his essay, *La Mosca nella Bottiglia*, [The Fly in the Bottle] the writer Raffaele La Capria uses the same metaphor of the title to explain the situation. The architect/fly is clearly aware of these new problems, for example, energy-saving in buildings, only after having studied technical physics in an exam/bottle. However, he's very far from understanding it and using it in a design. So it would be much more logical and feasible to study the pros and cons of an experimental building experiment and analyse them using incontrovertible data. This is what's missing! It seems as if everything that is experimented is fine, without saying how fine, without comparing it to time-honoured and consolidated traditional solutions. To achieve technological know-how, these are the guidelines needed to train an architect and the entire educational chain must take responsibility for this.

This type of work/project - based on the study of architectures considered innovative either because of their style or the inventions they use - runs the risk of being considered an "anthological" project, calling into question how to effectively replace academic education.

Given the above, the research we are proposing is based on the analysis of built architectures and other tests that have already been conducted. The most recent one seems to be the most effective vis-à-vis the problems we have highlighted the possibility:

- to study technology using examples and not theoretical conceptualisations;
- to present the examples as alternative building methods – emphasising the huge number of solutions available – using a scientific observation type of presentation to avoid repeating traditional methodologies to present technologies as mythical pseudo-cultural styles;
- to consider the non-consolidated alternative building forms as part of a study to find positive experimental projects and turn them into consolidated forms;
- to simplify the selection of alternatives by identifying comparative elements and present them in a manageable, comprehensible form.

To achieve this goal, we found it useful to use graphics (drawings, graphics, three-dimensional models) normally used by professionals, turning them into "concept maps" that link the examples to well-known classifications (technological systems, performance data, etc.). Each example has three headings: *why* (the reasons why a technology is chosen, reasons that stem from the classification of the characteristics of a building element); *what* (the description of the chosen element according to technological classifications); *how* (description of the materials and methods used). In the diagram, each topic is shown to be related to all the others. A short sentence links the type of building method to the overall design choices.

By examining more than one example, the latter become case studies that contribute to improving knowledge about a certain technique or building element. Multiple case studies of architectures made with innovative casings, for instance, contribute to a wider debate on the comprehension of that particular building element.

To achieve this goal, next to the "detailed technical sheets" drafted for each example- we have placed "concept maps" [3] for each element of the architecture, highlighting the similarities between important concepts behind the specific technological data. The detailed technical sheets (case histories) can be used to change or update the structure of the concept map: it is a "work in progress" tool. By applying a rigid reference table to the characteristics of the illustrated example and analysed detail, we believe it's possible to identify a method that is useful to understand technology and the tools that have become an integral part of the training of an architect, over and above their own creativity.

4. Conclusions

The experiments carried out so far have shown:

- it's necessary to study technology using examples and not theoretical conceptualisations;
- the study should make people aware that many alternative building methods exist, based on a scientific and not mythical approach towards technology;
- the alternatives include both consolidated building methods and satisfactory experimental methods that can be consolidated;
- choosing between the alternatives requires thorough comparative studies that are easy to manage and understand;
- an easy, comprehensible way to analyse alternative technologies is based on the need to formally insert examples into concept maps.

The apparent return to conceptualisation, after having rejected it as a principle, is not a dog biting its tail, because the study - the core of this discussion – is the study of the examples to be used to train creative architects making it scientifically beneficial for the wide range of specialists working in the field of construction [4].

References

[1] Asimow M. (2006) *Principi di progettazione*, Marsilio, Bologna.

[2] Lawson B. (2006) *How designers think*, Architectural Press, Oxford.

[3] Novak, J.K. and Gowin, D.B. (1984), *Learning how to Learn*. New York, Cambridge University Press.

[4] Morabito G. (2004) *Scienza e arte dell'innovazione in architettura*. Utet Torino.

Applied ontologies in the knowledge management of construction processes

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Technical knowledge integration is time consuming, requires intensive negotiatiosn and process flows aiming at to achieve the design and planning performance in construction projects. Traditional taxonomic approach of project management through the task decomposition could be usefully extended through an ontological approach to the task description. The ontological analysis allows to produce and experiment knowledge bases to support the communication and the management processes. The research objective is the development of knowledge bases supported by ontologies to analyse domain knowledge, to make domain assumptions explicit of tacit or informal knowledge, to enable reuse of domain knowledge. The expected result will provide an integrated approach to support the knowledge bases elicitation in the construction management oriented to the development and the implementation of a co-operative system of knowledge management

Keywords: Ontology, Knowledge Base, Construction Management

1. Ontologies in KM

Traditionally intended as a philosophical discipline, the term Ontology is used in the fields of knowledge management and of information technologies to describe a theoretical or a computational artefacts [1 and 2]. T. R. Gruber defined the ontology as a “specification of a conceptualisation” [3]. The ontology is specified and formalised through specific artefacts representing the meaning assumed in the terms of nature and structure of the related entities. In different terms an ontology represents the attempt to elaborate a conceptual schema that could be exhaustive and rigorous in a specific domain. Generally an ontology is expressed through a hierarchical structure of data containing all the entities that are relevant, their explicit relations, the rules, the axioms, and the constraints specific for the domain [4]. In general and in the field of the ontological study of a technological domain a development of ontologies either foundation either computational is required.

2. Application research field

The ontologies are commonly applied to the computer science field for representing and sharing knowledge. The computer programs apply the ontologies to a wide range of objectives, e.g. the inductive reasoning, the classification, the techniques of problem solving, to facilitate the communication and the information exchange between the systems.

A foundation ontology, not related to a specific applicative domain and attempting to describe more general entities, is also defined a constitutive ontology or upper ontology. The constitutive ontologies are considered to usefully develop, supported by constitutive concepts, and axiomatic structures, specialised ontologies maintaining a coherent and integrated structure. Nevertheless the actual studies on the upper ontologies are fundamentally theoretical neither de facto a standard has been until now recognised. That means at the state of the art a crucial part for the ontology usability is not available. Domain ontologies were developed in numerous domains [5]. The domain ontologies can be applied to support the modelling of:

- the physical object and the relative features, e.g. topological, morphological, cinematic, and functional;
- the information and the informative processes through ontologies of semiotic relations, studies on the ontological nature of data, documents, files and so on;
- the ontological fundaments of the classification of subjects or relative to social interactions, ontologies of planning and control, transactional ontologies, linguistic acts ontologies, and ontologies of relation in cooperation processes and so on
- the ontological fundaments relative to the organisations, legal or financial entities, laws and contracts and so on.

3. Objectives for the KB development

One of the factors of the recent rediscovered interests about the ontologies is principally related to the knowledge sharing or the cooperative production of knowledge. This objective requires several premises as a set of requirements that are to be achieved, e.g. to explicit the domain knowledge, to analyse and compare different vision/comprehension, and to facilitate the process of the knowledge sharing through the reified, shared structure of the information. First of all the ontologies permit to make clear and explicit assumptions, and to reuse the domain knowledge. Further as a secondary effect on the methodological level of the distinction between taxonomy and ontology we can identify a separation of declarative knowledge of the domain from operational and procedural knowledge.

4. Methodology

Aiming at a rapid prototyping of the system, an ontology editor permits to separate the task of the ontological study, under the responsibility of the domain experts, from the study on the reasoning engine and on the semantic web under the responsibility of the knowledge engineer. The model of a substantial concurrent engineering of the research requires to hybrid some competences and to analyse the interaction between the research actors.

On the domain analysis field the main issues relative to the ontologies development is the definition the different level of ontologies implied in a specific knowledge base:

- frame knowledge; that in terms of knowledge management we can classify as repository;
- knowledge functional to a problem solving approach;
- procedural knowledge workflow and others applicable to test, data catalogues, and systematic observation.

5. Results

The relevance of the development of ontologies allowing a basic support for an heterogeneous community of practice is discussed. Sharing common understanding of the structure of information among people or software agents is one of the more common goals in developing ontologies. To reduce uncertainty of the management process the knowledge-acquisition proceeds in well-defined stages and that knowledge acquired in one stage could be used to generate and customize knowledge-acquisition tools for subsequent stages. In Protégé was defined as an application that takes advantage of this structured information to simplify the knowledge-acquisition process

The objective of knowledge sharing in the knowledge management is a challenging task, dependent from social process of knowledge production. Ontologies of the specific domains can play a powerful role as paratextual tool representing the author's conceptualisation on a specific topic. Customisation and generalisation of ontologies are part of a knowledge management approach to the semantic web.

Nevertheless the profiles of user and contributor are functionally separated the specific knowledge domain is addressed to an actor profile that is in the same time contributor and user. This requirement outlines a specific approach of research development in order to coordinate the ontological analysis on the domain and the development of the semantic web application

The Knowledge bases production and maintenance requires a well structured organisational approach able to design the workflow, the knowledge tasks and the competences interfaces. Through a concurrent engineering approach implemented in the system architecture is possible to activate positive feedbacks between the actors of the knowledge base.

Guidelines and prototype models are developed to implement knowledge bases in the community of practice. Ontologies production could be supported by a design pattern approach able to identify the basic elements of the ontologies representation. The approach is oriented to support the interoperability of competences conjugated with the software interoperability.

References

[1] Masolo C., Oltramari A., Gangemi A., Guarino N. Vieu., (2003) La prospettiva dell'ontologia applicata, in Rivista di Estetica, n.22 anno XLIII, Ed Rosenberg&Seller, Torino

[2] Wikipedia: voce ontologia (informatica), www.wikipedia.org

[3] Gruber T., (1993), Toward Principles for the Design of Ontologies Used for Knowledge Sharing. Technical Report. Knowledge System Laboratory. Stanford University

[4] Buchanan, B. G., Barstow, D. K., et alii. (1983). Constructing an expert system. In F. HayesRoth, D. A. Waterman, and D. B. Lenat, (Eds.), Building Expert Systems . Reading, MA: Addison-Wesley.

[5] http://protege.cim3.net/cgi-bin/wiki.pl?ProjectsThatUseProtege

Consideration of IAQ issues in application of sustainable design and construction strategies

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Sustainability in design and construction of personal dwellings, as well as commercial structures, has become a global issue. Through best practice guidelines, design and construct goals set by municipalities, socially responsible self imposed programs, and other strategies, we can see that there is a wide spread support for taking some type of corrective action as we plan for the future. However, as we encourage altering our design and construction processes to strive for this goal of more responsible building, we must also be cognizant of occupant comfort, health and safety. One specific perspective that needs to be carefully considered is the provision of acceptable indoor air quality in these spaces. This paper describes specific strategies that are implemented in the LEED (Leadership in Energy and Environmental Design) system in the United States of America that pertain to indoor air quality.

Keywords: Sustainability, Indoor Air Quality, Occupant Comfort, Health and Safety.

1. Introduction

Many countries have functioning programs to increase awareness and effectiveness of guidelines to facilitate society's response to sustainable building concerns. In America, the leading program is known as LEED.

LEED certification is based on a point system that is achieved as a result of highly responsible design and construction practices. Each classification level - Certified, Silver, Gold, and Platinum - requires a minimum number of points, and brings with it a different level of respect regarding ability to attain sustainability goals. In the LEED system, there are prerequisites that were established to prevent the development of indoor air quality problems in buildings and to prevent building occupants from exposure to environmental tobacco smoke. While points are not awarded without first meeting these prerequisites, some points may be recognized as synergies. While all indoor air "pollutant sources" cannot be completely removed from buildings, this paper discusses these LEED related strategies for minimizing exposure to pollutant sources and/or occurrence rates therein. In addition, this paper assesses the effectiveness of the current LEED indoor air quality requirements.

2. Causes and impacts of poor Indoor Air Quality

"Poor IAQ is a result of poor construction techniques and project delivery, as well as substandard maintenance procedures." [1] Studies performed by the EPA suggest that building related illnesses in the USA account for between $60-$400 billion of lost productivity annually. [2] Legionnaires Disease, Mold, and Sick Building Syndrome are also caused by poor IAQ. IAQ expert, Dr. Vyt Garnys, cited negative impacts of poor IAQ as "lowered mental alertness, eye or throat irritation, and a general feeling of unwellness" – all of which "lead to stress." He also noted that it is "likely that sensitivity to poor environmental conditions is heightened when building occupants are stressed due to their work environment." [1] The World Health Organization has extensively studied the effects of poor IAQ and identify cancer, allergies, asthma, lung disease as additional concerns. [3] Hal Levin, research architect (Levin & Associates) identifies the major sources of indoor pollutants as "the outdoors, the building itself, the occupants, building equipment, appliances, and consumer products." [4] Knowing that essentially everything (including the occupants) is a source of contamination to the environment and air quality, we must seriously consider the approach to mitigating the adverse effects.

3. LEED, the point system, & practices

During the ten years since LEED was established, approximately 3,700 projects have been registered and 483 projects have been certified. These statistics are double that which was reported 12 months ago. Globally, Australia, Canada, China, France, Hong Kong, India, Cote d'Ivoire, Japan, Spain, Mexico, Italy, Guam, and Guatemala, have all expressed interest in LEED. [2] LEED has multiple tracks for various types of projects: LEED-NC for new construction, LEED-EB for existing buildings, LEED-CS for core & shell projects, LEED-CI for commercial interiors, LEED-H for homes, and LEED-ND for neighborhood developments. [2] The most prominent track, LEED-NC will be the focus of this paper. As of January 2006, for the projects previously listed as registered and certified, approximately 3,100-3,200 of those registrations were for LEED-NC projects and 382 LEED-NC projects have been certified at some level.

4. Products

EQ Credit 4 is primarily restricted by products that meet the emissions requirements associated with VOCs. These products are tested and certified by Greenguard, a non-profit organization.

5. Results

The United States Green Building Council has noted many positive impacts of pursuing IAQ LEED Points, including healthier and safer indoor environments, thereby increasing productivity, reducing absenteeism, and improving morale. Prince Street Technologies (production plant) noted a significant reduction in worker accidents once they opened their new daylit facility. [2] Psychological studies show that individuals tend to accept a wider range of temperature/humidity if they have control over their own personal space. [7] Studies also show that students who are exposed to daylighting score significantly higher on tests than students who are not exposed to daylighting. [8] Because the American College of Allergy, Asthma and Immunology estimates that Americans spend 80-90% of their time indoors, IAQ is a significant issue to be considered during design and construction. To date, the effectiveness of the IAQ strategies that have been implemented have been qualitatively analyzed via employee satisfaction surveys, which have been overwhelmingly positive. Dr. Vyt Garnys suggests that the occupant and related costs account for 90% of the total operating costs in most built environments. [1] According to Hal Levin, Research Architect, "Public opinion in the United States (and around the world) indicates that people are supportive of environmental protection even if they must pay a modest additional economic cost." [4] However, based on studies by leading researchers, such as Greg Kats, the economic analysis of the return on investment for the additional costs associated with the LEED requirements is not entirely paid back by energy costs, as some may imagine; but rather by the human factors related to indoor air quality and its impacts. [10]

6. Conclusions

Indoor Air Quality is a global concern. Over the past ten years, LEED has become the most renowned practice towards improving the built environment in the United States of America. Although LEED is only a requirement in a few cities and government agencies in the USA, many private owners are voluntarily becoming proactive and striving to build better buildings. The wide variety of possibilities to achieve points in the LEED system allows owners, designers, and contractors to customize the IAQ plan depending on the level of concern and building use. As the trend continues for owners to require more of designers and contractors to ensure the highest levels of indoor air quality, the approaches that have been outlined in LEED's EQ credits are proving to be effective methods of action for sustainability with respect to IAQ practices, regardless of whether or not a project is pursuing LEED certification.

References

[1] Garnys, Dr. Vyt, Ph.D., Current Trends for IAQ, Ecolibrium, April 2003.

[2] United States Green Building Council, LEED-NC Technical Review, 2005

[3] Guidelines for Air Quality, World Health Organization, Geneva, 2000

[4] Levin, Hal. Ten Basic Concepts for Architects and Other Building Designers, http://www.buildinggreen.com/elists/halpaper.cfm

[5] United States Green Building Council, unpublished data (as of January 2006) obtained from Dara Zycherman via email.

[6] Libby, Brian. Greenguard: A Rating System for Indoor Air Quality. http://metropolismag.com/cda/story.php?artid=599

[7] Barcik, Mike. LEED Technical Review Workshop, Birmingham, AL. May 17, 2005.

[8] Heschong, Lisa, et. al. "Daylighting in Schools", www.h-m-g.com

[9] BOMA, EPRI, Statistical Abstract in RMI "Greening the Bottom Line", 1994.

[10] Kats, Greg. Green Building Costs and Financial Benefits. http://www.cap-e.com/ewebeditpro/items/O59F3481.pdf

Knowledge management approach for conservation of earthen architecture

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The goal of the research project is to establish an advanced integrated approach to conservation of Earthen Architecture Heritage (EAH) that support main design and planning of conservation actions, reducing the technical risk through suitable and compatible measures. The conservation of the Earthen Architectural Heritage (EAH) is a challenging domain of competence resulting from the intersection of scientific, empirical and practical knowledge, either tacit either implicit. The research aims at developing an ontological perspective. The relevance of the development of ontologies allowing a basic support for an heterogeneous community of practice is discussed. A cooperative system of knowledge bases allows to support the workprocess that requires to recognize and to manage the inputs that are partial determined or undetermined (e.g. as external conditions, interdependence relations). The approach is expected to make advance in knowledge management field applying some specific concepts explicating and representing dynamic knowledge for action.

Keywords: Knowledge management, ontology, semantic web.

1. Introduction

The core goal of the "EAH conservation KM system" project is to establish and test an advanced Knowledge Management approach to conservation of Vernacular Architectural Heritage oriented to support and improve main and more critical design and planning actions. The local applications, cumulating thousands of years of practical and local experiences, of rich and effective tacit knowledge, as well as the modern contemporary applications make the earth architecture not only rich for its variability, but also for its capability to adapt to very different environments.

The results of the systematic scientific work developed in the last decades on EAH are collected in manuals and have generated technical codes from all over the world: this important scientific work have generated an a-systematic set of knowledge not related to local and traditonal tacit and implicit knowledge. The Knowledge Management approach for EAH conservation is oriented to propose a web based collaborative space to support as an effective interaction and cooperation between the partners as the technical and local communities operating onearthen architectural heritage.

The expected result will provide a web based Knowledge Management tool for supporting the main conservation design actions of Earthen Architecture, flexible to the different building cultures and adapted to the different operative conditions, for more effective, suitable and compatible conservation design measures.

2. An ontology for the EAH conservation

The core of methodology is an ontological analysis to produce and experiment knowledge bases to support the communication and the conservation design processes in the specific field of earthen architecture. The identified strategic objective is the development of knowledge bases supported by ontologies to analyse domain knowledge, to make domain assumptions explicit of tacit or informal knowledge, to enable reuse of domain knowledge that is one of the core objectives to which ontology research is addressed. [1] [2] The scenario of ontology-editing environments offers a range of achievable general purpose tools, such as Protégé-2000 (Protege 2000) [3], Ontolingua (Ontolingua, 1997) [4], and Chimaera (Chimaera 2000). We have selected Protégé-2000 as the ontology editor for generating the KM prototype.

The Protégé applications are a set of tools that have been evolving for over a decade, from a simple program which helped construct specialized knowledge-bases to a set of general purpose knowledge-base creation and maintenance tools. An ontology defines a common vocabulary for researchers who need to share information in a domain. It includes machine-interpretable definitions of basic concepts in the domain and relations among them. The key performances expected from an EAH ontology are focussed on:

- to analyse domain knowledge: that means to represent and to design and to manage the decision processes through the whole conservation process (design, diagnosis, testing) based on a workflow paradigm and integrated by cause effect diagrams, check list, specific risk assessment forms, etc., effectiveness, compatibility, sustainability assessment tools, protocols supporting the technical diagnostic;

- to share common understanding of the structure of information among people or software agents: a collaborative space to support the cooperation between the partners. The workflow approach is directed to structure the core of a net for the cooperative and concurrent knowledge sharing through an adequate methodological and instrumental base;to make domain assumptions of explicit and tacit knowledge related to selected conservation processes;
- to separate domain knowledge from the operational knowledge;
- to enable reuse of domain knowledge

3. An environment for a collaborative work

Sharing common understanding of the structure of information among people or software agents is one of the more common goals in developing ontologies. For example in order to the EAH preservation it is reasonable to achieve an affordable set of approaches, testing methods and procedures for field testing as a technical and scientific support for the earthen architecture conservation decision processes to be undertaken, and a virtual place in which all the actors involved in the conservation process can participate in the most cooperative way to conservation design processes. Suppose several different documents or projects (cases) contain diagnostic information or provide planning and prevention protocols. If these documents share and publish the same underlying ontology of the terms they all use, then computer agents can extract and aggregate information from these different sites. The agents can use this aggregated information to answer user queries or as input data to other applications.

A shared base of ontologies, i.e. a web based groupware system, permits to satisfy the basic knowledge requirements of designers and others coming from different nations, with common rooted cultural and educational backgrounds and involves the review of contents considering quality, quantity, and structure. Expository, technical data, and fluid or tacit knowledge, cases and story telling of main conservation design actions and prevention measures for the maintenance of EAH, as well as a catalogue of standards and recommendations, bad and best practice, are the elements that can be implemented in a base of ontologies. [5]

A flexible access to a shared workspace system provided either through internet with shared access means, or through dedicated supports to the on field campaign, is able to support the operators towards a collaborative data exchange for the development of specific design/planning solutions and for enhancing the project robustness according to the knowledge and the technical material used.

Enabling reuse of domain knowledge is one of the core objectives to which ontology research is addressed. For example the earthen architecture is characterized by a high level of technical variability and integration in geographical and cultural environments and together with its traditional good performances this constitutes a relevant part of its. Models for many different domains need to represent local/tacit technical knowledge with the scientific knowledge, to support designers for the more critical design actions and to orient and support the diagnostic and testing processes, although leaving to the designer the responsibility of analysing, evaluating and reducing the failure risks through the appropriate preventive actions (and tests shall be included in the main preventive actions). If one group of researchers develops such an ontology in detail, others can simply reuse it for their domains.

4. Expected results

The expected result is an experimental tool able to support the operators towards a collaborative data exchange for the development of specific design/planning solutions and for enhancing the project robustness according to the knowledge and the technical material used. It also aims at integrating all the extensive potential of data and therefore all the different sections will be linked through an indexing system that will allow the access to the implemented earthen architecture knowledge base.

5. References

[1] S. W. Tu & M. A. Musen (1999), *A Flexible Approach to Guideline Modelling*. AMIA Annual Symposium, Washington, D.C., 420-424 . 1999

[2] Noy N. F. and McGuinness D. L. (2001), *Ontology Development 101: A Guide to Creating Your First Ontology*, Stanford University, Stanford

[3]Protege (2000),. *The Protege Project*. http://protege.stanford.edu

[4]Ontolingua (1997), *Ontolingua System Reference Manual*.http://www-ksl svc.stanford.edu:5915/doc/frame-editor/index.html

[5] McGuinness, D.L., Fikes, R., Rice, J. and Wilder, S. (2000). An Environment for Merging and Testing Large Ontologies. *Principles of Knowledge Representation and Reasoning: Proceedings of the Seventh International Conference (KR2000)*. A. G. Cohn, F. Giunchiglia and B. Selman, editors. San Francisco, CA, Morgan Kaufmann Publishers.

A local sustainable approach of building industry development in Piedmont

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The main objectives of this paper is to demonstrate that in an ecologically sensible area (like in this case of the Alta Langa region in Piedmont) with the support of local government, is possible to design a future building industry development integrated in the local ecosystem, respecting the local cultural tradition and using local building materials.

Keywords: building industry, sustainable development, glocal/local approach, stone material, construction techniques

1. Introduction

Currently, the construction industry accounts for approximately one third of the world's total energy consumption, and 40% of its consumption of materials. New buildings and their infrastructures, the quarries and mines that produce the materials they use, the plants where these materials are processed, and the landfills where construction and demolition waste are disposed of all eat up larger and larger swaths of land. Though from the standpoint of globalization, it may be cheaper – and more conducive to market competitiveness – to quarry raw materials far from the construction site, have production and manufacturing operations carried out elsewhere, and produce on an industrial scale, from the standpoint of sustainability the costs of shipping, production, demolition and disposal will be enormous, because all these activities consume large amounts of energy and environmental resources. At the same time, this process of globalization gradually saps the cultural, social and economic life of local communities. Though it would take a political economist to give an exhaustive answer to this question, we can nevertheless observe that certain areas of Italy have been moving in the opposite direction in recent years.

Wherever highly specialized building traditions have strong roots, perhaps because certain particular materials are locally available, small construction companies have flourished. Not uncommonly, small and medium enterprises have banded together to form highly specialized consortia that supply products and services of outstanding quality. This is the case of several construction companies operating in regional settings such as Piedmont's Valle Bormida and Valle Belbo, where Langa stone, a building material that has been used and worked by the local population for centuries has encouraged the survival and growth of many businesses, most of which are family-run operations.

2. The socioeconomic and regional context [1]

In the mountain communities of the Belbo, Bormida and Uzzone valleys, a number of small firms have revived the area's traditional stone masonry and characteristic roof slabs, taking age-old skills and adapting them to modern construction techniques. This reassessment of a material and the preindustrial local economy that centered on it was initiated by local administrations, and that of the Langa delle Valli mountain community [2] in particular, who introduced polices designed to promote the area's growth by leveraging its unique history and culture.

These policies were put to work in a setting that has seen more than its share of environmental tribulations. The Langa delle Valli mountain community was established after 1987, the year that the Italian Ministry of the Environment designated the zone as an "area at high risk of environmental crisis" because of the pollution caused by the former ACNA chemical plant in Cengio.

From the time of the conference organized in 1988 by the Associazione Rinascita della Valle Bormida in Cortemilia, the local administrations' primary goal – alongside combating pollution – was to develop a model for regional growth firmly rooted in the valley's environmental heritage, landscape and traditional human assets. The multi-year socioeconomic development plan presented by the mountain community was thus premised on making the best and fullest use of the resources offered by the area's heritage. Without doubt, these resources include Langa stone and the techniques used in working it.

Today, anyone who travels the roads leading towards Liguria, winding through the Langa hills, is certain to be struck by the area's beauty, with its broadly terraced slopes crowned by gray dry-stone walls.

3. Craftmens in stone

One of the objectives of this study was to update the rather scanty data published by the mountain community's administration regarding the businesses who currently work with Langa stone. These companies were asked to complete a questionnaire designed to provide information about the following aspects: general information regarding the type of company organization, dealings with designers (draftsmen, engineers and architects), type and cost of completed projects, stone procurement methods, and the company's past, present and future.

The responses to the questionnaire indicated that most of the businesses working with Langa stone, or around 70% of the total, are very small enterprises. Only 27% are incorporated for tax purposes, while the remaining 3% are one-man businesses, mostly farmers who work as building contractors on the side. As for the type of work carried out, around 76% are building contractors who do both conversion/restoration work and new construction, 15% process or install Langa stone (i.e., the company markets Langa stone blocks, slabs or other dimension stone products for use in construction, and also builds stone walls and installs outdoor paving), around 2% produce stone slabs and other dimension stone products but do no installation work, and the remaining 2% are small handicraft businesses that product art objects and the like. In terms of size, 75% of the total have fewer than three salaried employees, and are thus for the most part family businesses. As regards age, an interesting fact emerges from the questionnaires which testifies to the sector's growth and expansion: 53 % of the workers are between 31 and 45 years old, and 17 % are between 15 and 30. All in all, a full 70 % of the people who work in the sector are under 45 years old. The (relatively) recent origins of the area's economic resurgence is also indicated by the dates on which the businesses were founded: around 50%, in fact, were set up after 1990.

As can be seen, the sector is in good health on the whole, and enjoys good prospects for future growth. In order to respond more effectively to the challenges of a globalized world, however, it is essential that the businesses in the sector move quickly to achieve greater economies of scale, not so much by increasing their size, as by changing their mentality. As we have seen, most of these operations are very small, family-run operations whose horizons stop short with finishing the job. As for small and medium enterprises in other sectors of the Italian economy, there is thus little or no incentive towards innovation and improvement in product quality. From this standpoint, it is significant that only 26% of these businesses plan to hire additional personnel in the next few years. Yet another revealing point that emerges from the survey concerns the workers' lack of knowledge about the main chemical, physical and petrographic properties of the stone they use. Thus, it has become common practice in recent years to make extensive use of cement mortar in Langa stone constructions. Not only was this unknown in traditional construction work, which chiefly employed dry wall techniques or lime mortar, but it can also trigger potentially dangerous changes in the material and detract significantly from the building's image and appearance. In a scenario as full of contrasts as this, where bright lights are offset by deep shadows, it is crucial that local government be capable of promoting and regulating growth.

4. Survey results

This investigation has shown that it is now possible, and will be even more so in the near future, to compete successfully on a globalized market and ensure sustainable development by leveraging the qualities that set a particular area apart, and promoting a wider knowledge of them.

Where the global market aims for uniformity, turning out standardized products at low cost – and low quality – a local economy can only be competitive by putting its own distinctive features to effective use, with a full awareness of its own cultural and environmental heritage and the value of doing high-quality work.

References

[1] Montaldo E. (2006) *La Pietra di Langa, un materiale tra tradizione costruttiva e innovazione tecnologica*. Second-cycle degree in Construction Engineering, faculty advisors Mele C., Castelli M., and Scavia C., Politecnico di Torino, academic year. 2005-2006

[2] Introini M., Filippetti R., (2005) *Pietra di Langa*, Comunità Montana Langa delle Valli Torre Bormida (CN)

[3] IED (2005) *Pietra di Langa & design, 13 progetti di giovani designer.* Comunità Montana Langa delle Valli Torre Bormida (CN)

Sustainable wooden house production

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Sustainable wooden houses is a frame for two projects that have been carried through by Mid Sweden University. The projects "Optimization of wooden constructions " and "Healthy Wooden Houses" are parts of a major research programme at Mid Sweden University entitled "The forest as a resource" financed by EU structural funds. The results from the projects so far indicate that optimization of wooden constructions makes a contribution to the economizing of natural resources and that wooden houses are comparably healthy regarding the formulated criteria.

Keywords: Sustainable building, building production, wooden houses, timber houses, indoor environment

1. Introduction

The projects "Optimization of wooden constructions " and "Healthy Wooden Houses" are parts of a major research programme at Mid Sweden University entitled "The forest as a resource" financed by EU structural funds. The aims of the projects are to develop sustainable wood building in the region and to find guidelines for creating healthy houses with wood as the primary building material. The final report of the project was ready in February 2006.The criteria for sustainable building are good environment regarding indoor, outdoor and work environment factors. Other important aspects are aesthetics, quality and economical factors.

The most important risk factors in office environments appear to be ventilation, moisture problems, cleaning and the occurrence of strong pollution sources such as photocopiers and air humidifiers (*Sundell 1994; Sundell and Kjellman 1994*) [1]. Building materials have not been shown to be significant in this context other than when they have an incorrect moisture content (self-levelling compound, chipboard etc.). Occupation of newly-painted premises can also play a certain negative role.

Wood as a natural material has good potential for providing a basis for healthy building. It is, however, very important that it is treated in the correct way. If used incorrectly, wood can also give rise to a poor indoor environment. This applies to all stages of the building process, from production through to operation and maintenance.

Architect Ingrid Svetoft in her licenciate thesis made a study of the users'/clients' demands for a good indoor and work environment. A case study was made on the rebuilding of the university campus in Östersund (Svetoft, 2005) [2][3].

The project includes case studies on sustainable wooden house production based on the criterias above with focus on what is already known from good and bad examples.The project is linked to a certain extent to earlier projects with employee contribution conducted by Mikaelsson (1989 and 1992) [4] [5] and Söderberg (1989) [6].

2. Purpose

The purpose of the subprojects "Optimering av träkonstruktioner" (*"Optimization of wooden constructions")* and "Sunda trähus" (translated as "*Healthy wooden houses*"; see translator's note) [7] were to increase knowledge about wood as a construction material and its competitive strength in comparison to other materials, and to clarify criteria for decision-making necessary in the building process to create healthy timber buildings and other buildings constructed mainly from wood.

3. Implementation, methods and results

The aim of the subproject "Healthy wooden houses" was to find guidelines for the sustainable building of wooden houses. The first step was to clarify the criteria in the building process of importance to the creation of healthy houses with wood as the main building material. In the beginning of the project six criteria for healthy building were formulated based on previous research. These were the consideration of the outdoor environment, indoor environment, work environment, economy, quality and aesthetics.

In the formulation of the criteria economical aspects should also be considered. In her doctoral thesis Gunnel Bångman studied how tenant-owners value a good indoor environment (Bångman, 2004 and 2006) [8] .

One of the aims of the subproject "Healthy wooden houses" was to find guidelines for how combined natural and mechanical ventilation should be constructed to fulfil the needs and demands of a wooden house. That means how to achieve enough air flow in all rooms under different circumstances. In his licenciate thesis *The air distribution in buildings with combined natural and mechanical ventilation* Gunnar Åhlander (2004) made a study of the area [9] [10] [11] .

4. Conclusions

In short the results from the projects so far indicate the following conclusions:
Optimization of wooden constructions makes a contribution to economizing of natural resources.
Wooden houses are comparably healthy regarding the formulated criterias.
The wood building process requires an increasing cooperation between building companies and wood house manufactories in order to improve the logistics with optimized solutions between site and factory constructions. There is great potential for improvement in this field.
The wood building concept has a positive impact on the work environment on the building site especially concerning climate, noise and physiological working conditions.
Wood house building might catalyze the industrialization of the building process with improvements in working environment, more effective production planning, work organisation and leadership.
The projects have been evaluated by professor Bengt Hansson at Lund University as external examiner. In the report it is stated that the projects have been successful and have given good contributions to increase the knowledge in the field [12].

References

[1] Sundell J, (1994), *On the assosiation between building ventilation characterististics, some indoor environmental exposures, some allergic manifestations and subjective symptom reports, Indoor air, Supplement 2, 1-148*

[2] Svetoft, Ingrid, (2003), *The users' requirements in the building process regarding environmental and quality demands- a case study on the Östersund Campus*, Paper presented at Third Nordic Conference – Construction Economics and Organisation Lund Institute of Technology, Lund University, 23-24/4 – 03

[3] Svetoft, Ingrid (2005), *Brukarnas krav i byggprocessen* **-** *en fallstudie*; Licentiate treatise. Institutionen för byggvetenskaper, LTH, Lunds universitet, 2005.

[4] Mikaelsson L-Å.,(1989), *Byggnadsarbetarens involvering i planeringen av byggprojekt 1989:2*, Högskolan i Sundsvall och Avd för Arbetsmiljöteknik LTH, Lund

[5] Mikaelsson L-Å (1992), *Bygga inför 2000-talet,* Byggförlaget, Stockholm

[6] Söderberg J, Schröder C, (1989), *Integrerad planering – Försök med arbetstagaremedverkan vid planering av byggprojekt,* Avd. för Byggekonomi, LTH

[7] Mikaelsson, L-Å. (2003), *Healthy Wooden Houses*, Paper presented at Third Nordic Conference – Construction Economics and Organisation Lund Institute of Technology, Lund University, 23-24/4 – 03

[8] Bångman, Gunnel (2004), *A Valuation of Good Indoor Air Quality in Swedish Dwellings/Motives for Valuing Good Indoor Air Quality – Altruism or Egoism,* Articles presented in dissertation (2006)

[9] Åhlander, Gunnar (2003), *Annual variation of air distibution in a cold climate*. Proceedings of the 24th AIVC Conference, Washington, USA

[10] Åhlander, Gunnar (2004), *Stack ventilation of rooms with closed doors*. Submitted to Roomvent

[11] Åhlander, Gunnar (2004), *The air distribution in buildings with combined natural and mechanical ventilation.* Licentiate treatise, KTH, Stockholm 2004

[12] Hansson Bengt, (2005), *Extern utvärdering av delprojekt Industriell Teknik och Metodutveckling inom trä-, bygg- och skogsindustrin – ett delprojekt inom Skogen som resurs*; Höllviken December 2005

The recovery of the landscape: the quarries as resource for the contemporary city. The case of Apulia region

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In a territory strongly humanized as that Italian, a particularly delicate theme is that of the quarrying activities and the finding of raw materials as the construction stones. These quarry areas are nowadays places of the landscape in which is evident, more than in other parts, the problem of the restructuring of the form of the territory. This essay wants to show as the quarries can return in a virtuous circuit able to produce a new concept of 'sustainable construction' applicable not only to a single building but to a whole cycle that holds in consideration whole portions of territory. The quarries may become architectural forms that find their last meaning in the contemporary city. The methodology adopted to describe this process is based on the description of a Model-study applied at the analysis of case-study focused on the extractive areas of Apulia region (Italy).

Keywords: Transformation landscape; Sustainable construction of the territory; Building materials (history, production and use); Building techniques in response to their environments.

1. The quarries as resource for the contemporary city

In a landscape like the Mediterranean one, where the vegetation made extremely difficult the survival of living communities devoted to agriculture, since the first human settlements, the subsoil has always constituted an irreplaceable source for the survival of a whole community. The Mediterranean basin is geologically very young. The special homogeneity of the subsoil (predominantly calcareous), the lack of wood for the building and the rapid accessibility to the stony resources, easily extractable, particularly almost spread out in the whole territory and easily to be worked, brought the process of building only in that direction.

2. A cultural model: the Mediterranean landscape and the culture of the excavation

The Mediterranean man has always had a strong action of transformation in relation to the landscape and the soil. The Mediterranean soil is a shaped one, educated, built by the man according to his needs. The water, too, is not easy to find in the Mediterranean soil; the limestone has the capacity to take this precious liquid for short period of time. Man has learned to exploit this quality of the soil, canalising the rainy water and the few superficial sources, gathering them in tanks, wells, excavation spaces around which he has organized his own settlement. The historical settlements had learned that the calcareous soil could keep the water and it could also be offered as a very good stuff for the building and its surface could be transformed into a fertile territory, even though it was partly bare and arid. During the whole Mediterranean basin, the excavation and the building characterized as different phases of the same building process, producing two different types of urban space, characterized each by specific functions, shapes and articulations. The urban superficial space and the subterranean one are made by the same stuff, the first one in positive and the second one in negative and the town shows all this in an extraordinary stratification, along its streets.

3. An interpretative model: the landscape of Puglia and the different shapes of the excavation space

In Puglia the whole region is characterized by the succession of three different geological steps which, starting from the coast and coming to the inner land, are distinguished into a space of recent alluvial warp, one of tuffaceous rocks and one of calcareous rocks. Reaching the inner part of the region, the different compactness of the subsoil is in relation to a different way of shaping the buildings, the town and the landscape.

The tender lime stone can be easily worked. The extremely workability of this stuff allows the production of great excavation spaces of an extreme geometrical precision, so that they can assume an absolute continuity with the built spaces. The compact lime stones (marble) is strong, resistant, difficult to be worked. The excavation shapes become, in this way, very few and assume a minor formal control and are strongly different from the remaining part of the structure.

In Puglia, is particularly evident the process which corresponds the variation of the shapes of the towns and its architecture, according to the variation of the compactness and the characteristics of the subsoil. In a space like this, the quarry is continually present in the landscape. It was easy to dispose the settlement in relation to some areas where the man could directly reach the resources of the subsoil.

So the relationship between quarry and urban system produced a “great economies” cycle and a limited aggression of the landscape based on:

a) to find the raw materials *in loco*
b) to produce a direct relation between the excavation and the construction
c) to allow great economies in the research of the material, in its transport and activation
d) to allow a great economy in the time of building and in the workforce necessary for the productive cycle
e) to produce, with the excavation, a space in negative, once it was united to the building, which allowed an evident increment of the utile volume permitting to reduce at the minimum the surface really erected

With the industrialization, the process of production, transformation and consume of the landscape upsets. The increasing necessity of raw materials brought the quarries to assume always bigger dimensions. The growth of the quarry did not follow the growth of the towns. The quarries went gradually away from the living settlements. Apart this, the quarries had never constituted a so strong economy to survive without the presence of the towns. So, the quarries, even they were pulled away from the towns, did never removed a lot from them, and they especially placed themselves along the railways and routes of the region.

4. A Planning project: the excavation, the quarry and the new dimension of the human landscape

These spaces can now assume an important role in the organization of the landscape of Puglia: these shapes distributed on the territory in zones of an extreme importance for the development of the urban systems and of the arranging logics of the territory. At the actual situation, from a lecture of the territory of Puglia, we can observe the presence of two different types of extractive settlements: the first ones, established along the extra-urban roads, near one or more urban systems; the second ones, more recent, strongly industrialized and greater than the previous ones, placed near the main roads and the railways of the national and international market. Paradoxically, along those road internal axis, develop nowadays new urban tensions.

Following this principle, it is possible to adopt, for the territory of Puglia, a planning model imposing a transformation of the spaces occupied by huge quarry craters in new places of the human landscape, able to host activities accepted by the modern town with an extreme difficulty to its inner land and little settlements alleviate the excessive demographic pressure of the main urban areas.

5. Survey results

The shapes of the quarry become areas where one can concentrate new urban poles, able to diminish the demographic pressure, but also spaces for service activities (cultural, commercial, services and recreational ones), investing always more the traditional town, making it collapse under the weight of the infrastructures, the traffic and the pollution.The reference scales of the contemporary architectural reflection have certainly extended, imposing the study and the control not only of the urban shapes but also of the landscape hosting them. The contemporary landscape now asks for an updating of the relationship between town and territory, soil and subsoil, architecture and landscape.

References

Archibugi Franco (ed): 2002, *La città ecologica. Urbanistica e sostenibilità,* Bollati Boringhieri, Torino.
Bindé Jérome (ed): 1998, Cities and environment in the twenty-first century, A future-oriented synthesis after Habitat II*, Futures,* vol. 30, n. 6, pp. 499-518.
Bissanti A. A.: 1990, Il paesaggio pugliese della pietra a secco*, in* A. Ambrosi, E. Degano, C. A. Zaccaria (eds), *Architettura in pietra a secco, Atti del I seminario internazionale “Architettura in pietra a secco”*, Schena, Fasano, pp. 115-129.
Bolund P., Hunhammar S. (eds): 1999, Analsys, Ecosistem services in urban areas*, Ecological Economics* (29), pp. 293-301.
Di Rubba C., Palmiero C.: 1997, Il recupero delle cave come architettura del paesaggio, *Quarry & Construction*, febbraio.
Montalbano, C. (degree thesis): 1998, *Paesaggio delle cave, Cave sotterranee, spazi ipogei, strutture di servizio,* Bari.
Montalbano, C. (Phd' thesis): 2002, *La riforma del paesaggio mediterraneo: le forme del suolo e del sottosuolo nella progettazione architettonica contemporanea degli spazi di cava,* Palermo.

Understanding the effects of building life on asset maintenance management

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The maintenance of building assets is all about restoring the buildings to acceptable standards of both health and safety. Rectification of building life entails the understanding of the complexities of such 'life' especially in an age where buildings are a conglomerate of components. The survey study looks at missing characteristics of this building life concern in the management of public infrastructure. The paper proposes the need for a pervading 'philosophy of building life' to be the springboard of any maintenance action.

Key Words: Building Life, Performance, Investment

1. Perceptions of building life

Richardson [3] concretely asserts that perceptions of building life are time related – mainly the time individuals or organizations would hold interest in the building asset. There is relative agreement over the fact that a buildings' life can stretch over 60 years. Flanagan [4] sees this 'time relation' in the sense of a 'birth', 'life' and 'death' of a building (that spans the 60 years) that he characterizes as having a physical, legal, economic, social, functional and technological life. The importance of any building investment is in the fact that such investment are for long-term prospects than for short-term gains.

So crucial is this all-embracing concept of investment that the consequent building life holds by the objectives underlying it. Building life, therefore, involves sustaining the performance of a buildings' envisaged life (over the investment period). Longevity of life has been at the root of the quest for the preservation of assets. Even Egypt's long-standing pyramids undergo renovation. Recognized in the life of a building is the fact that it is dynamic, as age and deterioration, are both dynamic.

2. Performance of an asset

Performance embraces the ability of a building and its parts to function properly. Implied in efficient functioning is the durability factor.

The new type of building systems that contemporary architecture has introduced combines numerous subsystems, whose materials undergo several pressures that increase their deterioration.

Performance in buildings is synonymous to the word 'life expectancy' owing to the fact that it holds the very tenets of long-term projection.

3. The use of notional lives of components

As far as building life is concerned, the use of notional lives has great advantages for the management of asset portfolios. These are:

1. Notional lives would assist in the setting of criteria for the technical assessment of the portfolio condition.
2. Notional lives assist in the setting of policies that would streamline the level of maintenance needed for the envisaged life. Top priorities identified and dealt with as a result.
3. Notional lives would assist in the setting up of organisation of maintenance as far as work force planning is concerned to be able to handle 'predicted' problems.
4. Using notional lives provides a formidable basis of attaching cost to building life rectification.

4. Survey results

The survey reveals the need to instill building life philosophy if public property maintenance management must see the light of day by:

1. Proper choice of building materials that will have the period of investment in view. Durable materials, using their notional lives, ensure that planned preventive maintenance programmes are set in place.

2. Proper methods and quality of construction ensure that buildings will have longer lives and hence influenced by this philosophy through the employment of skilled artisans.

3. Environmental effects bearing on the building need properly trained, knowledgeable professionals to manage property well.

4. Use of building must focus on the function for any choice of materials.

References

[1] Elliot, C (1971) Constraints in the Economic Development of Zambia, University Press, London

[2] Markus, T and Lorimer, N (1984) "Industrial Refurbishment" in Architects Journal, 26 September 1984, pp. 77-90

[3] Richardson, D (1985), "The Investor" in Chartered Surveyor, November 1985, pp. 12-14

[4] Flanagan, R and Norman, G (1983) Life Cycle Costing for Construction RICS, London, pp. 12-45

[5] Seeley, I, (1983) Building Maintenance, Macmillan Press

[6] Then, D, (1989) EOQC Seminar, Implementation of Quality in Construction

[7] Maintenance (1991) (Journal) June, pp.11

[8] Then, D, (1989) *ibid*

Camaraderie and the ‘craic’: exposing blue-collar relationships in the UK construction industry

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Anecdotal evidence suggests that the construction industry workforce have a propensity to experience ‘camaraderie’ during their working day. However, despite this well founded claim, there is a paucity of empirical research on this issue. This paper explores some of the variables that may be attributable to camaraderie and makes suggestions for the direction of future inquiry into this issue.

Keywords: Camaraderie, blue collar, construction workers

1. Introduction

The culture of the construction industry can be exemplified by projects and the behaviour of teams that are assembled to design and build them. Demonstrations of camaraderie can be considered as a symbolic representation of team behaviour that is embraced by some or all members of a project. Indeed, it may be that subcultures within projects organize themselves so as to seek negative outcomes and an act / episode of camaraderie is equally powerful in uniting this group. Common thinking suggest that camaraderie is always linked to positive outcomes through ‘bonding’ or ‘gluing’ a ‘cohesive’ team and this is conceptualized though discourse that emphasizes ‘mateship’ and ‘solidarity.’

2. Research methodology

The original intention of this paper was to report on a small pilot study investigating the views that blue-collar construction workers have on camaraderie. However, given the paucity of empirical research on camaraderie within the construction industry, this paper provides a literature review which creates a framework for future empirical studies.

The intention hear is to provide a foundation of knowledge and provide a bridge between the anecdotal evidence and empirical research from other disciplines with discourse from the construction industry. This can be regarded as conceptually integrating available literature. It seeks to identify relationships between the various constructs and develop a firm understanding that would provide a roadmap (as opposed to a hypothesis) for use during the empirical research phase. As such, given the novelty of this research topic in construction, the proposed research will be investigative and theory building.

3. Builders camaraderie: Myth or reality?

It appears a widely held believe that ‘builders’ and thus by implicit association, all those employed within the construction have / engage in ‘camaraderie’. Particular to UK social culture, the ‘cheeky builder’ with ‘his’ builders bum (euphemism for male building workers with low slung jeans exposing top flank of bare buttocks!) continue to display disregard for the political correctness emphasized by supporters of professionalizing the blue-collar workforce. The image is particularly well exemplified by a television serial- *Auf Widersehen Pet* that followed the exploits of a seven-man gang of builders abroad. Indeed, the BBC [1] note that camaraderie between the gang was ‘brilliantly captured’ by its writers. Further evidence of the portrayal of camaraderie in construction can be seen in a 1990 film- ‘Riff- Raff’. The director cast actors who had actually worked in construction to complement the realism of the writers experience within the industry.

4. Discussion

The review thus far touches on evidence of camaraderie within the construction trades and this permits tentative synthesis that provides insights and questions for future empirical work. Perhaps most importantly, can we prove the existence of interpersonal blue-collar camaraderie within the construction industry?
The following questions are therefore provisional and open to revision in light of the descriptive research that will constitute the next phase of this project.

- Can camaraderie be ‘measured’ and classified to the extent that a pilot study would provide valid findings that would allow for repeatability or is this a synergistic concept that is contingent on environmental and personal constructs.

- What is the relationship between camaraderie and positive work aspects such as increased productivity, better health through reduced occupational stress etc and negative aspects such as deviant behaviour and how do we determine cause and effect? Is camaraderie the 'chicken' or 'egg'?

- What impact does age and gender have on camaraderie? Does a 17 year old women apprentice decorator have a different frame of reference to that of a 64 year old male retiring stonemason and what impact does this have on what constitutes camaraderie/

- What is the propensity for 'within' trade / work-group camaraderie compared to inter-trade? Specifically, do some occupations (i.e. steel fixers, carpenters, plumbers) have different experiences of camaraderie?

- What impact will the routine activities undertaken by individual trades have on camaraderie? It could be that ground workers (concreters, steel fixers) may find working conditions and welfare facilities less amenable than finishing trades and this may encourage an 'esprit de corps' ?

- Does the employment structure of the industry impact on camaraderie i.e. what impact does self employment or direct labour has?

- Will the type of project (domestic, house building, commercial, civil engineering) have an impact on camaraderie due to their inherent site specific environmental differences? In a recent study Dainty et al [2] found that operatives working on a new cancer research project exhibited affinity to towards the project outcomes. It could be argued that this affinity would also be apparent within interpersonal relations amongst the operatives and may engender camaraderie?

- What impact does supervision (project manager, foreman, clerk of works) have on camaraderie or is craft autonomy responsible for promoting these feelings?

5. Conclusions

Despite a paucity of empirical research into camaraderie within the construction industry we see that it is an issue commonly associated with this sector and cited by insiders and outsiders alike. However, the topic requires exploration so as to lay a firm foundation for future work. There is a need to uncover the variables before plotting them on a chart that will give assistance in steering the research through the four phases noted by Greenberg and Tomlinson [3]. Furthermore, we have chosen not to examine camaraderie within the professional occupations in construction, although Ogunlana et al's [4] paper did provide contrasting evidence of blue and white-collar construction workers perception to humour on site.

References

[1] BBC Tyne (2006) Auf Wiedersehen Pet www.bbc.co.uk/tyne/hollywood_on_tyne/auf_wiedersehen.shtml (accessed 05/10/2006)

[2] Dainty, A.R.J, Bryman, A, Price, A.D.F, Greasley, K, Soetanto, R and King, N (2005)
Project affinity: the role of emotional attachment in construction projects, *Construction Management and Economics* 23, 241–244

[3] Greenberg, J and Tomlinson, E.C (2004) *The Methodological Evolution of Employee Theft Research*, In Griffin, R.W and O'Leary-Kelly, A.M (edits) The Dark Side of Organizational Behaviour, Jossey-Bass, San Francisco, 426-461

[4] Ogunlana, S, Niwawate, C, Quang, T and Thang, L.C (2006) Effect of Humor Usage by Engineers at Construction Sites, *Journal of Management in Engineering*, 22 (2), 81-88.

Utilising classification of innovations to stimulate innovations in construction

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Innovations in construction may be classified in several different ways. To provide encouragement to construction firms in Singapore to innovate, this study had the aim of providing a practical approach to the classifications of innovation that is able to guide construction firms in their development of innovation strategies. From interviews with 21 construction practitioners, this study found the profit maximisation goals of construction firms to be a major driving force of innovation. It was concluded that the classification of construction innovations should be in accordance with the types of benefits and returns that emerge from them, which makes the investments of money and effort in innovation worthwhile and effective. In addition, a co-operative partnership between clients and contractors is useful for contractors to strategise their strategic direction and types of innovation.

Keywords: Innovation, construction cost, profit maximisation

1. The Role of national institutions in construction

1.1 Overview

Innovation is a useful tool for the development of an individual's or enterprise's competitive advantage. However, construction firms can afford not to innovate because of the protection afforded by transport cost in site based projects [1]. In addition, as every construction project is at a new and different site and most often for a different owner, every project can be considered a prototype. Construction practitioners often interpret conventional construction practices and methods in new situations as innovative behaviour. However, there is no evidence of continuous improvements in the industry that such "routine innovations" should have brought about.

This study argues that the lack of a planned procedure in construction, which retains the know how for future reapplication, does not allow the deliberation and investigation process to be defined as R&D and for the "invention" to be called an "innovation". This study thus defines innovation as "the purposeful search for new knowledge and the *systematic* application of this knowledge in production", where systematic R&D processes should be a precedent of innovation. This study thus intends to investigate a suitable classification of innovation that guides contractors in their innovation approach.

1.2 Methodology

To understand contractors' views on innovations, in-depth, semi-structured interviews were undertaken in this study. Three groups of actors were selected for the purpose of interviews: main contractors, national institutions and construction clients. Interviewees were selected through convenience sampling. The groups and stratums of interviewees are shown in Table 1. A total of 21 construction practitioners were interviewed.

Table 1. Number of interviewees for each actor

Group	Stratum	Minimum number of interviewees	
Local Contractors	Small	3	
	Medium	3	
	Large	3	
	Total number of interviewees for "Local Contractors"		9
Foreign Contractors	Total number of interviewees for "Foreign Contractors"		3
Clients	Public	3	
	Private	3	
	Total number of interviewees for "Clients"		6
National Institutions	Total number of interviewees for "National Institutions"		3
	Grand Total of Minimum number of Interviewees		21

2. Construction innovation by contractors

Regarding innovation, firms are essentially seeking rents through either introducing a new product or applying a new production process [2]. Hence, the root problem of poor growth in any industry may be due to the repeated failure to capitalize on the power of profit incentives to induce productive efforts, investments and innovations [3].

Although profit is a possible driver of construction innovation by contractors, there are "costs" in acquiring innovation. In general business theories, these "costs" are usually imposed on firms undertaking innovations. For business investments in innovation to increase, there must be adequate incentives to invest [3]. Nonetheless, "cost" of innovation is often regarded as high for business in general and construction in particular. Therefore to provide a practical classification of innovation for the purposes of contractors, the focus of this study's interviews lies on the impacts of costs and profits on contractor's decision to innovate.

3. Results and discussions

From the interviewees' responses, the key finding of this study is that the responsibility of the finance of innovation is placed largely on the contractors. This issue proposes two further considerations.

First, since the funding of innovations is largely based on the financial capacity of contractors, their perception of innovation risks plays a fundamental role in their decisions to innovate. Nevertheless, innovations provide potential profit and intangible returns, which make such risks practicable.

Second, since the consumer's willingness to pay for an innovation may reduce the financial burden of innovating contractors, the categorization of innovations, in accordance with consumer's willingness to pay for an innovation, plays a fundamental role in the innovation strategy of contractors.

4. Recommended classification of construction innovation

From the results of this study's interviews, it is observed that innovation in construction may be classified into three main categories:

(i) Type 1 Innovations: Innovations which consumers are willing to pay for.
(ii) Type 2 Innovations: Innovations that reduce contractors' construction costs.
(iii) Type 3 Innovations: Innovations, which encompass intangible benefits such as a good reputation and high credibility, that provides contractors with sustainable competitive advantage.

The difference between Types 1, 2 and 3 Innovations is that the first two are demand oriented while Type 3 is supply focused. Hence, Types 1 and 2 form the basis of a reactive strategy while Type 3 supports a proactive and forward-looking strategy based on the needs of consumers.

For contractors to maintain a sustainable turnover for Type 1 Innovations, there has to be a continuous re-examination of the desires of consumers in order to derive the right signals of their level of satisfaction. Since clients are at the forefront of engaging with consumers, it may be useful for contractors to cooperate with clients to understand the demands and tastes of consumers to successfully strategise their innovations' type and direction.

5. Conclusions

The results concluded that a key driver of innovation in construction is the profit maximisation goal of construction firms. However, as innovation is a cost expense, the classification of the construction innovation should be in accordance to the types of innovation benefits and the returns from innovation that make the cost investments in innovation practical.

From this study's classification of innovations, it was also suggested that a co-operative relationship between clients and contractors is important in facilitating successful innovation strategies for contractors. Therefore, the findings from this study need to be augmented with further research aimed at the developing cooperative partnerships between contractors and clients.

References

[1] Gann, D. (2000). Building innovation: complex constructs in a changing world, Thomas Telford, London.

[2] Linde, C. and Porter, M.E. (1995). Green and Competitive: Ending the Stalemate, Harvard Business Review, 73(5), 120-134.

[3] Harper, J.D. (1963). Profitless Prosperity, Speech delivered at Annual Public Interest Luncheon, Dallas Management Association, Texas.

Formation of project managers: perspective from the UK construction industry

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This research is based on a MSc dissertation which sought to identify the formation of construction project managers in the UK construction industry. A number of factors were extracted from the literature review and were assessed by 47 project managers via structured postal questionnaire. Results of the survey indicated that today's PM generally holds an academic degree in engineering and practical qualifications such as HND and HNC. Result also shows that today's PM is less prepared for the managerial demands. The most important skills/knowledge for CPM are: decision making, leadership, negotiation, chairing meetings, delegation, correspondence, team working and planning and scheduling.

Keywords: project manager, education and training, experience, skill

1. Introduction

In the 1980s there was considerable growth in the provision of management education and training in the academic sector. Handy [2] states "the sense has now changed radically; no longer do British assume that anyone with any sense can manage anything" and Woodward [3] remarks that "more and more organizations are recognizing the truth of the phase 'Capable People: the heart of every project', and this has been the moving force behind the steady expansion in the number of appointments of project managers, and the emergence of relevant education and training".

The discipline of project management continues to evolve over time. Today, the recognition of project management as a profession has spread across all business sectors, from construction to IT, from time based to performance and quality based, from discrete operations to management by projects.

2. The changing role of construction project manager

Since the Second World War, the construction industry has been constantly changing to play a vital role in the UK. It is in the midst of great change – change in its customers, change in its competitors, change in the way that projects are produced and change in the technology that it uses [4].

Within such a changing industry climate, project managers increasingly find themselves accountable not just for the technical content of the project as expressed by the engineering and construction accuracy, reliability of the facility, and within-cost performance, but also their managerial capabilities that are beyond their traditional responsibilities.

After glancing through the construction project manager's role and responsibilities and establishing their changing role and how increasingly they are required to perform roles outside the traditional scope of project management, it can be hypothesized that there is a strong need for a broad background in order for the project manager to fulfill his/her role.

3. Methodology

In order to achieve the research aim, this investigation took the form of three stages. The first stage included the collection of comprehensive review of the relevant literature on the subject of the formation of construction project managers, in particular, looking at the past work in this field. The literature review sets the foundation of the research work. It has provided the background required to carry out most of the work through out this dissertation. The second stage contains survey of construction project managers. The third stage analyzed the data using the descriptive method of analysis.

4. Analysis of the results

This research showed that today's project managers generally hold an academic degree in engineering and practical qualifications such as the Higher National Diploma (HND) and the Higher National Certificate (HNC). Their academic course contents are technically based with very little space for other highly needed subjects.

With regards to further educational / professional qualifications, the data obtained in the survey indicates that after their initial and predominantly technological jobs the career of engineers may progress towards construction project management requiring an identifiable set of further knowledge and skills.

In accordance with the satisfaction of today's project managers with the training opportunities available to them, the survey revealed a satisfactory response. Though a considerable proportion of the respondents had difficulties in getting time off the job to attend such courses.
The survey established that project managers in construction generally have to accumulate at least 5 years working-experience to attain the position of project manager. Over this 5-year period they would generally have passed through between 1-5 different posts. In addition, project managers acquire the requisite background experience on up to 10 projects before attaining this status.

This research aimed to identify the most important skills/ knowledge for construction project managers. Analysis of the results, showed the following ranking: 1. decision making, 2. leadership, 3. negotiation, 4. chairing meetings, 5. delegation, 6. correspondence, 7. team working and 8. planning and scheduling. This finding indicates that the common ingredient in the range of skills necessary for effectiveness is the project manager's ability to communicate with others.

In most cases the contribution of academic programmes to the development of project managers is rated lower than that of formal training they achieved while on the job. This is due to the fact that participant project managers have generally acquired some years of working experience. Accordingly, this makes their academic background far-off to their instantaneous positions and so they are unlikely to consider this background as having a direct impact on their formation and development. Similarly, the respondents' emphasis on formal training was out-ranked by that of experience on the job. However this finding suggests that the formal training also have contributed to the formation of our construction project managers. Therefore this finding confirms that employers need to pay more attention and recognize the importance of such training courses.

References

[1] Al-Dhayf, S. (2004), Formation of project managers: perspective from the UK construction industry, unpublished MSc dissertation, UK: Department of Property, Surveying and Construction, *London South Bank University*.

[2] Handy, C (1987), "The Making of Managers", A report on management education, training and development in the USA, West Germany, France, Japan and the UK, London: *Crown*.

[3] Woodward, J.F (1997), Construction Project Management: Getting it right first me, London: *Thomas Telford Services Ltd*.

[4] Bedelian, H.M (1996), "successful major projects in a changing industry", *Proceedings of the Institution of Civil Engineers: Civil Engineering,* Volume 114 (3), 117-123.

Probabilistic decision models to support complex sustainable design processes

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This paper proposes and presents a methodology for the development of probabilistic designing tools, which are thought for application during the rough sizing phase of sustainable buildings, allowing designers to perform a trial or error approach. This procedure is then applied to develop a particular probabilistic model for the design of roofponds for passive air conditioning of buildings. The whole model is made up of 16 interrelated Object Oriented Bayesian Networks (OOBNs), optimized through the use of sensitivity analysis and validated through numerical and experimental data. A designer can analyze, criticize and improve its preliminary project through the use of this multi-criteria probabilistic model, because he/she is aware of the causal relations among the involved variables. Through opportune validation the model is shown to constitute a valid procedure for complex system modeling.

Keywords: Bayesian networks, sustainable design, artificial intelligence, roofponds.

1. Introduction

According to the standard attitude towards sustainability, most of the times designers are provided with fixed typological solutions that impose upon them a lot of constraints in the stage of building drawing and few experts are available to assist them; therefore architects prefer to adopt traditional construction technologies instead of trying systems with a high risk of failure. That problem can be solved through the development of Object Oriented Bayesian Networks (OOBNs) [1], in the form of an intelligent support tool. This paper aims at explaining the potentials of such an approach through the construction of a probabilistic Bayesian tool applied for the modeling of roofpond technology.

2. Probabilistic tools for roofpond modeling

The probabilistic model is developed using the tool of Bayesian Networks. They consist of two parts: a graphical model and an underlying conditional probability distribution [1]. The graphical model is represented by a directed acyclic graph (DAG), whose nodes represent random variables, which are linked by arcs, corresponding to causal relationships among the previous ones and whose strength is quantified by conditional probabilities. The Bayesian explicit graphical representation provides a clear understanding of the qualitative relationships among variables, allowing the user to reason about their causal correlations. In addition, every node of a Bayesian Network can be conditioned upon new information, through the belief updating process deriving from the application of the Bayes Theorem. It is supported towards any direction of reasoning: from causes to consequences (“predictive” reasoning) or from consequences to causes (“diagnostic” reasoning). Finally, Bayesian Networks own the precious property of updating upon new evidence: it can be formulated by substituting the prior probability distribution with the probability distribution of the first event conditioned upon a set of old evidence and applying the Bayes theorem as in the previous case. In this paper we have chosen to build the probabilistic framework through the help of expert aids and then the parameters relative to conditional probabilities are estimated using the “sequential updating” method [2], that is a procedure to modify network’s parameters over time in order to improve its performances, and that allow the integration between two different kinds of information: the first deriving from approximated deterministic laws and the second from empirical or numerically generated data. In this paper an original procedure based on sensitivity analysis and case-based reasoning is suggested, to find out the optimum ratio between the numerousness of the two sets of data to be integrated.

Such an approach is applied for the modeling of the behavior of glazed roofpond sustainable technique. Roofponds are a form of high-mass construction system basically for one-story buildings. A branch of research is concerned with experiments on SkyTherm™ glazed roofponds, which are specifically designed for cooler climates and that are considered for the work in this paper: that system consists of a “ceiling pond” under a pitched roof (to resist snowfalls), conventionally insulated on the north side, and with clear insulated glass on the south slope to collect solar energy. Glazed roofponds were successfully tested in Muncie, Indiana, to show that they are able to make average internal temperatures closer to the comfort range than other sustainable techniques, increasing them during the winter and decreasing them during the summer [3].

3.The model

Once that all the conditional independences stating among variables are explicated and the graphical structure is built, an iterative procedure to quantify the corresponding conditional probabilities was set:

- a preliminary learning through the use of simplified deterministic relation was performed;
- one first preliminary updating of the previous conditional probabilities with data collected through numerical simulations was carried out;
- sensitivity analyses and case-based validations were applied for a first evaluation of the quality of the network;
- an iterative refinement of parameters was executed, adding further empirical information to the one already implemented on the second item, and evaluating it through sensitivity analysis and case-based reasoning, until a flat point was reached (no further improvements are allowed).

The final whole network is made up of sixteen elementary networks connected one another using the tool of Object Oriented Bayesian Networks (OOBNs), each of them simulating a particular physical process. They were split into three main levels: the first include all the Bayesian networks relative to the computation of internal solar heat gains and sky temperature, acting as inputs for the second level; the second level is aimed at computing internal air temperatures (means and swings) both for roof pond and reference buildings, working in heating and cooling modes respectively; the third level is made up of one huge model solving the decision problem of choosing the best combination of decision variables to optimize the project, through the adoption of an objective function. The refinement was used to prevent unreliability of the model, that could rise from quantification of conditional probabilities through the application of just an approximate numerical model. Sensitivity was evaluated for several probability updates (learning), computing the entropy values relative to several probability quantifications: the closer it is to zero the more sensitive is the network, thanks to the adding of empirical information. Once the model had been built, it was successfully validated comparing its results with the ones supplied by transient finite difference simulations. The authors have individuated three practical applications of the Bayesian reasoning within the architectural design profession:

- support in the process of discerning the best choice among several likely building configurations, each of them with its own constraints from an architectural point of view;
- bottom-up reasoning, that is to say, querying the objective function for deriving the proper values that yield the highest utility for the particular issue being considered, in order to reach optimal sizing of building parameters;
- approximate sizing under conditions of uncertainty: making inference also in the case of uncertain distributions over several values.

4. Conclusions

In this contribution Bayesian Networks are shown to be a feasible support tool for rough sizing of roofpond buildings. It is possible to build those probabilistic models without renouncing to a friendly graphic interface, being capable of quantifying conditional independences among variables and coping with very complex systems, thanks to the possibility to break down the whole process into simpler sub-processes. All the queries that could reasonably rise at the preliminary stage of the project can be answered through the application of such a support tool. Thanks to the possibility to integrate knowledge of different kinds and to the possibility to handle rough data, this instrument can be considered as a great enhancement for the design of roofpond buildings and sustainable technologies. An iterative procedure, aimed at optimizing the probability learning procedure through the application of sensitivity and case-based techniques is outlined, until the network reaches its flat point, that means a level of accuracy that cannot be further improved through the use of the data at disposal.

References

[1] Korb, K. B., Nicholson, A. E. (2004) Bayesian artificial intelligence. *Chapman & Hall/CRC edition*.

[2] Spiegelalther, D., Laurintzen, S. L. (1990) Sequential updating of conditional probabilities on directed graphical structures. *Networks, 20, 579-605.*

[3] Fernández-González, A. (2003) Characterizing Thermal Comfort in Five Different Passive Solar Heating Strategies. *Proceedings A.R.C.C. 2003 Conference, Tempe, AZ.*

Optimization of acoustic performances of glazed facades through active control

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In highly inhabited urban areas buildings are often located near big infrastructures or noisy systems that make respect of the recently enacted European Directive 89/106/CEE a very ambitious task. The weak link in protecting the interior from exterior noise is represented by glazed surfaces, whose performances cannot be improved by the use of passive technologies, which are ineffective at low frequencies, where traffic, railway and airplane disturbances have the highest magnitude. This paper develops the ASAC approach, based on the reduction of structural vibrations and radiated sound. Through the use of an experimentally validated numerical model, several configurations for this control system were analyzed, showing how it is able to sensibly increase sound transmission loss of windows and analyzing the way they couple with interior acoustic fields.

Keywords: sound transmission loss, ASAC, glazed facades, piezoceramic actuators, active control.

1. Introduction

The 89/106/CEE European Directive, has made protection against noise a compulsory requirement for buildings. As a consequence building envelopes must provide the required acoustic comfort. In fact, glazed facades are the preferred path followed by disturbing noise from the exterior to the interior and are often not able to respect the strict limits imposed by standards and regulations, in spite of the adoption of very expensive passive means, which are laminated glass technology and double glazing [1]. Both of them can be useful for reducing noise transmission at high frequencies, while determining no improvements at lower frequencies. It could be shown, through the application of those calculation methods regulated by the European standard series EN 12354:2000, that when a glazed element having a sound reduction index sensibly lower than opaque walls is installed on a building façade, it acts as such a preferred path for the sound from the exterior to the interior that improving the opaque envelope's sound reduction index does not improve the overall STL of the wall, which in that case depends uniquely on the window's performances. In this paper, the adoption of an active control system is suggested to prevent the drop of acoustic performances of glass panels at low frequencies, showing how it is capable of controlling the vibrations of glazed panels and reducing the sound radiated as a consequence.

2. Active control for glass panels

Presently two main approaches are known for active control of sound [2]: Active Noise Control (ANC), where secondary waves interfere destructively with the disturbing noise, and Active Structural Acoustic Control (ASAC), when the source of noise is actively controlled through the reduction or modification of its vibration field, which is applied for the purpose of this paper, because it can be easily integrated in buildings, as it does not require the use of loudspeakers or error microphones in the receiving environment; instead ANC system needs an external microphone for disturbance monitoring, and internal error sensors and loudspeakers for control purposes. Therefore the ASAC system is preferred by the authors, because both reference sensors and actuators may be placed on the glazed panels as source of interior noise, which would interfere less dramatically with visibility and it does not require the use of loudspeakers or error microphones in the receiving environment. However there are not tested applications on glazed facades, and most of the experiments were carried out in the automotive and aeronautic fields of research [3, 4].

Feedback ASAC systems are made up of the following components: sensors to detect vibrations; electronic filters to analyze signals from sensors in order to check the vibration field induced by disturbance; an electronic controller to manipulate signals from the sensors and compute the most efficient control configuration at the actuators level; charge amplifiers to drive the secondary actuators on glazed panels according to the outputs sent by the controller; actuators to control the vibration field of glazed panels. Opportune algorithms are implemented in the controller to optimize the actuator actions. As far as concerns the choice of actuators, from a literature survey it was found out that two main typologies of PZT actuators are presently available on the market: piezoelectric patches and piezoelectric stack actuators. As the first is a rectangular shaped patch, it may interfere with visibility, instead the second one is very small but the need a stiffener to work properly and is preferred by authors.

3. Experimental results

A proper finite element model was developed in ANSYS^{TM} environment for static analyses on stiffness computations (the magnitude of force necessary to produce a unitary displacement) for a simply supported stiffener. The extreme joints of the stiffener are supposed to be hinged to the window's frame. In general, we can state that every time the reaction profile stiffness is comparable with the one of the actuators and much higher than the controlled system's one, it gives back opportune reaction forces. The solution successfully experimented is a rectangular cross sectional shaped steel profile, that supplies strong forces to the glass also for voltages under 50 V, which do not constitute danger for people. Previous to the numerical analyses, it is necessary to set a proper finite element model. As test case a rectangular (1.4x1.0) m glass plate, 0.006 m thick, simply supported along its edges was chosen for numerical and experimental analyses. A numerical modal analysis was carried out, and used to set the parameters of the finite element model through a comparison with the corresponding experimental results, where measurements were carried out through a Laser-Doppler vibrometer. Then, it was assumed that the aforementioned rectangular simply supported window is stroked by a harmonic wave at 140 Hz, whose noise level is reasonably the one that could be generated by a lorry traveling at low distance and at a speed of 70 km/h equals to 85 dB, and the mode (1,3) is the most excited. It was shown that applying three actuators along the minor axis, vibrating out of phase with respect to the disturbance, the final vibration field amplitudes are strongly reduced. However the release produced from an acoustic point of view may be estimated only analyzing the effects inside a test room. For that reason the previously tested window was supposed to be installed on one wall of a test room having the following characteristics: plastered walls and ceilings and back stalls on moquette floor. Assuming the same harmonic disturbing wave of 82 dB level and propagating at 140 Hz, like in the previous study, the resulting acoustic harmonic disturbance inside the room will have an average level of 66 dB, the minimum of 34 dB and the maximum of 78 dB. In case the window is controlled by the three stack actuators along the minor axis, with a consequent decrement of vibrations, a strong decrement of acoustic pressure level is obtained: the maximum peaks drop from 78 to 63 dB, thanks to the reduction of vibration amplitudes generated by the actuators, with a final drop of 15 dB. The average and minimum values drop respectively to 53 and 32 dB.

4. Conclusions

Thanks to the application of an active structural acoustic control system, it is possible to strongly improve the STL of window panels in the low frequency range: the presence of actuators drops dramatically the noise transmitted from the exterior to the interior, even if the disturbing wave is near its resonance effect. Coupling this system with laminated technology, that are effective at high frequencies, would allow to obtain good insulation properties all over the range of audible acoustic frequencies, determining an increment of transmission loss performances for the whole facade were such active controlled windows are inserted. In the particular case considered in this paper, where a relatively complex mode was excited, it was possible to obtain a sound reduction of the highest value up to 15 dB inside the chosen test room. Moreover it was shown that several technologic solutions are available for its installation on windows and that its functioning require the use of very low voltages, that cannot be considered dangerous for users. At this stage it is possible to conclude that the ASAC system is a feasible and effective solution for the improvement of acoustic comfort inside buildings, therefore further research will be conducted to produce a first prototype of that active controlled window.

References

[1] Fahy, F. (1985) Sound and structural vibration: radiation, transmission and response. *Academic Press, London - San Diego – New York – Berkeley – Boston – Sydney – Tokyo.*

[2] Fuller, C. R., Elliott, S. J., Nelson, P. A. (1997) Active Control of Vibration. *Academic Press, 2nd Edition, San Diego-London- Boston-New York.*

[3] Fuller, C. R., Snyder, S. D., Hansen, C. H., Silcox, R. J. (1992) Active control of interior noise in model aircraft fuselages using piezoceramic actuators. *AIAA Journal, 30(11), 2613-2617.*

[4] Petitjean, B., Legrain, I., Simon, F., Pauzin, S. (2002) Active control experiments for acoustic radiation reduction of a sandwich panel: feedback and feedforward investigations. *Journal of Sound and Vibration, 252(1), 19-36.*

Systems for real time construction site management

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This paper analyzes the scenario of automated building construction site management, pointing out the areas where new technologies like Radio Frequency Identification (RFID), Global Positioning System (GPS) and wireless networks could have significant impact. It introduces a general model of a building construction site that is suitable for automation purposes, and discusses its application to management, safety control and inspection support. The advantages and the limits of applicability of RFID, GPS and wireless networks technologies are then identified. Some implementation details in real construction sites will be also provided.

Keywords: Building Construction, Construction Management, Safety, Mechatronic, RFID, GPS.

1. Towards the automated building construction facility

Building construction sites are designed for making unique, large and often very complex products. The construction facilities are therefore nomadic and are custom designed. The management of a building construction site is a very complex task, it requires a large number of controllers, that daily inspect the site, collecting information, so that the managers can be informed about the progress of the construction. Recently, a bounce of new low cost and highly standardized technologies, like Global Positioning Systems (GPS), Wireless Networks and Radio Frequency Identification (RFID), and some research achievements in mechatronics provided the technological background for the development of innovative management scenarios for highly automated nomadic construction facilities.

1.1 Information management

The interoperability between building design and construction can be greatly improved by providing on-site access to technical documentation and by collecting in real-time the data of construction progress. On-site exchange of technical documentation can be based on a client-server system that provides location and task-aware (adaptive) mobile computing (based on position tracking and wireless distributed communication) that allows:

- retrieving and storing graphical and textual information related to the position and the orientation of the operator and to his current activity;
- assistance for paths and objects findings;
- assistance for communication with other operators and with a remote experts.

This technological framework supports on-site inspections by providing technical drawings, bill of quantities, expected finishing time of works, and any other technical information contained in the central product data and work flow management system. It also supports tracking construction operation by allowing field workers to automatically store progress information (e.g. reports, photos, videos, etc.) necessary for later inspection/monitoring tasks and, eventually, for coordinating the following works on the same place. In this case, the system ergonomic should be carefully designed in order to minimize the disturbance of the workers' activities (e.g. user interface that is customized for the task and the environment in which it is used, data input by "pointing and clicking" or speech recognition, visual and acoustical checks of user input, etc.).

This technology enhances the effectiveness of management by providing efficient and reliable data collection, facilitates the construction of "as-built" reliable document base that eliminates paperwork and errors, enables electronic processing of data and creates meaningful evaluations of the construction progress more efficiently.

1.2 Safety

One of the big challenges of an automated building construction site is the minimization of the risk of accidents traditionally related to construction. Statistics show two main kinds of risks of accident in workplace:

- *risk related to environmental conditions*: involving both machinery (e.g. possible erroneous set-up, bad conditions of the components, etc.) and environments (e.g. terrain falling, etc.).
- *risk related to operational conditions*: bad interaction among humans and objects/machinery (collision with mobile and fixed objects, workers trapped between objects, injuries caused by incorrect use, etc.), movement in complex, high rise paths (e.g. falling from falseworks, falling from rooftop, etc.).

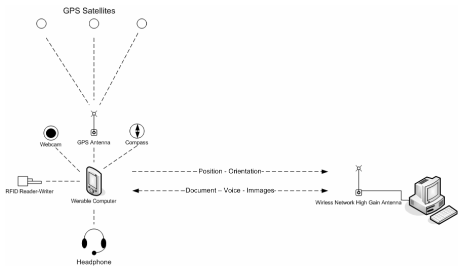
Automation can significantly lower the risk of accident by means of three technologies: position tracking, of both workers and machinery, real-time communication and on-site transportation of materials. Position tracking is used to trigger dangerous conditions and to rise alarms that will be communicated to involved operators in real-time through point-to-point communication channels. On-site transportation of materials is aimed at minimizing workers' moving across high raised risky paths. In general the topology of a construction site terrain is so complex and unstructured, for example in comparison with the groundwork of an industrial production facility, that a complete automated supply chain of materials and tools is in general unfeasible. Nevertheless, movements on falsework are one of the main cause of fallings. Movements are mostly caused by tools and light material supply, since they are not usually provided by high load cranes. Furthermore falseworks are well structured working space. Therefore automated falseworks, able to move light materials and tools among its working levels are conceivable.

3. Implementation issues

Any implementations of automation policy for the construction site share some fundamental issues:

- *Identification*: any automation systems is necessarily based on the automatic identification its components. An automated building construction facility requires the possibility of automatically identifying workers, materials and tools. RFID technologies allow unique codes to be stored in electronic tags and red at distance.
- *Position and orientation tracking*: in nomadic building production facilities the spatial arrangement of works is rather sparse. Therefore tracking workers, tools and materials is a fundamental condition. In particular workers tracking requires both the identification of position and of head orientation. GPS can provides reliable data (5m of tolerance).
- *Distributed communication*: in distributed production lines fixed point-to-point communication is unfeasible. A communication system that is accessible from every point of the production facility and that can be dynamically routed to every other point is required. Wireless networks can suit the task.
- *Movements of materials and tools*: perhaps the most challenging issue is automating the supply chain of materials and tools. Usually building construction cranes are few and applied to movement of large quantities of materials and of heavy loads. Light tools and small quantities of materials are mostly moved by hand. The unstructured and dynamically changing ground walking paths of a building construction facility makes the automated supply of light materials and tools a challenging issue. In some places (e.g. falseworks)the structure of the working place is adequate and robots with specialized ergonomic can be designed to suit the specific task.

The real time management framework requires a centralized server that is able to collect and share information and to coordinate the management activities. Figure 1 show a client-server system where: object identification is based on the RFID technology using passive 13.4MHz tags; position tracking is based on GPS, and can be used either for workers and machinery; orientation is determined by means of an electronic compass; the distributed communication system is implemented by means of an high bandwidth wireless networks.



References

[1] Abderrahim, E. Garcia, R. Diez and C. Balaguer (2005) A mechatronics security system for the construction site, Automation in Construction, Volume 14, Issue 4, August 2005, Pages 460-466
[2] Akinci, B.; Boukamp, F. (2002) Representation and Integration of As-Build Information to IFC Based Product and Process Models for Automated Assessment of As-Built Conditons. International Symposium on Automation and Robotics in Construction, 19th (ISARC). Proceedings. National Institute of Standards and Technology, Gaithersburg, Maryland. September 23-25, 2002, 543-549 pp, 2002.
[3] J. Reinhardt, J.H. Garrett, USA; B. Firmenich, K. Beucke, H. Kreutzjans, W. Katzer (2005) Progress Manager: IT-Support for Progress Data Collection on Construction Sites, Structural Engineering International (SEI) Journal Volume 15, Number 3.

General contracting versus PCM: the Italian way

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This paper intends to explain how Italy has interpreted, since 2001, the third type of European tender procedure introducing (through law 443 known as "legge obiettivo") the role of "contraente generale", improperly translated as general contractor. And how it has applied it to some 15 major contracts which have been let out so far without yet proper monitoring. The objective is to demonstrate that the Italian way, compared with other European examples, lacks a clear transfer of risks and allocation of tasks.
Methodology: Comparison between the Italian frame of reference and the content of the best specialised literature available abroad.
Results: Recommendations on how to improve the Italian approach (adapting it to the new European directives) in order to better fit within the ppp framework including the adoption of pcm services to strengthen the skills of owners in governing the construction process.

Keywords: Building procurement, Project management, Construction management, General contractor, Turnkey method.

1. Introduction

The so-called "legge quadro" (law no. 109/1994) governs the award and execution of public works contracts in Italy.

In addition, a recent new piece of legislation has simplified the procedure for the award of strategic infrastructure and industrial projects identified by the Government on an annual basis (law no. 443/2001, called "legge obiettivo").

A few months after the enactment of this law, the Italian Government has also passed the legislative decree no. 190/2002, which provides for a sort of "fast track" regulation for the aforementioned strategic projects.

This decree complements the "legge obiettivo", introducing and disciplining the "contraente generale", a new player which has been modelled upon the European directive 93/37, interpreting the "third type" of tendering procedure: i.e. a figure which will be responsible for "the realisation, by whatever means, of a work corresponding to the requirements specified by the contracting authority".

"General contractor" is the usual and more common translation suggested by a large majority of authors for the Italian word "contraente generale", but this apparently obvious correspondence does not help to draw a useful profile of it.

Which kind of procurement process applies to the new player defined by law no. 443/2001 and legislative decree no.190/2002? A brief review of just few (and mostly positive) comments on this innovation offers a large array of opinions, lacking however any clear or univocal definition. the portrait of the "contraente generale" drawn from these different points of view does not yet emerge for the following reasons:

- it is other than a "construction and management concessionaire" [5], despite the fact that:
- its activity can easily bring this figure to the *ppp* definition, as adopted in the Commission paper Com (2004) 327 final (especially considering that the "contraente generale" must partially "pre-finance" a public work), although void of exploitation risk [6], and although:
- it appears to be similar to a fixed-price turnkey contract with the awarding authority, according to a *design, build, finance and transfer (dbft)* scheme [3], even if:
- it refers to an *epc (engineering procurement and construction)* scheme of contract with certain features ot its own [4].

2. Building procurement systems classification

Following the classification established by Mastermann and Perry for the purpose of assisting the clients in the selection of the most suitable building procurement system, the possible options are the following:

- Separated procurement systems or conventional systems
- Integrated procurement systems
- Management-orientated procurement systems, like management contracting, construction management and design and manage
- Discretionary systems

3. Applying the classification to the "contraente generale"

Two procedures seems to meet the "contraente generale" model closer than other procurement variants: the "Design & Build" scheme (especially in its variant know as "Fixed-price turnkey contract") and the "Design and Manage" scheme. A deeper analysis allows to demonstrate than for different reasons, both these schemes -as usually adopted in international building procurement- do not meet the profile drawn by the Italian ad-hoc legislation of 2001/02.

Then, in the italian "contraente generale" scheme remains ambiguous how the legislator has intended to reinforce the client position against the contractor, a goal which is generally achieved establishing means and measures of control during and after the construction phase. Thus resorting to services internationally known as *pcm (project/construction management).*

4. Conclusions

In Italy the application of the "legge obiettivo" has so far concerned the award of 15 large public work contracts (including the eventual construction of the bridge across the Messina Strait) for a total amount close to 13 billion euros. But no evidence is yet available as to improvements which might derive to the procurement/management/construction process. Waiting for such "feedback", in the light of the recent change of Government and of the serious strains to the State budget, a pause in the experimentation of this new scheme seems advisable.

If specific suggestions can be made, the first is the need to recognise that whenever a public client requires "prefinancing" from a prospective contractor, it is an obvious case of *ppp* scheme in which the *public private partnership* should also extend to the phase immediately following construction: i.e. operation of the built facility. This seems essential not only to assure that quality is delivered and checked trough time but also that the contractor has a larger (and longer) payment on which to rely in order to make advance payments to the client reasonally "bankable". This is especially advisable if Italy wants to favour the growth of few general contractors large (and strong) enough to compete with counterparts from other European countries which, at the moment, by far outweigh them. In this aim it is essential that Italian public clients improve their management skills: to achieve this goal in the short term contracting authorities should resort to the services of professional *project/construction managers (pcm)* to help them govern the whole process and make sure that the works are delivered in time, at cost and with quality adequate to the stated performance requirements.

References

[1] Freshfields Bruckhaus Deringer, *PPP in Europe: an overview*, London 2005

[2] De Pierris, Luigi, *Improving the Infrastructure*; PFI Journal, no.40, Jan 2003.

[3] Vigliano, Franco, *Legal Framework for infrastructure Projects in Italy;* Stretto di Messina SpA Roadshow, New York, 2004.

[4] *Italian Government Relaunches Project Finance in Public Works and Strategic Infrastructures*; GOP Newsletter; Sept 2002.

[5] Picozza, Eugenio, *Le concessioni, il general contractor e la finanza di progetto*, IISA, Bologna, 2005.

[6] Mastermann J.W.E., *Introduction to building procurement systems*; Spon Press, London, 2002 (II ed.)

[7] Perry J.C., *The development of contract strategies for construction project*, University of Manchester, 1985

[8] Dearle and Henderson, *Management Contracting - a Practice Manual*, Spon Press, London, 1988

[9] Bougrain Frédéric, Carassus Jean, Colombard-Prout Marc, Antonini Ernesto, Koch, Christian, Winch Graham; Partenariat public privé et bâtiment en Europe: quels enseignements pour la France? Retour d'expériences du Royaume-Uni, d'Italie, du Danemark et de France; Presses de l'École Nationale des Ponts et Chaussées, Paris, 2005

[10] Norsa Aldo (a cura di), La gestione del costruire tra progetto, processo e contratti, FrancoAngeli, Milan, 2005

The naivety of partnering assessments

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Construction managerial literature often argues that gains are to be made by using partnering, in terms of reduced cost, reduced delays and/or increased quality. Voices have been raised to approach partnering in a more critical perspective i.e. to look at both advantages and disadvantages when investigating the phenomenon of partnering. This paper is an attempt to go in that direction. In order to assess the effects of partnering in valid way, the evaluation needs to (i) be based on project facts and not personal perceptions, (ii) make a comparative analysis including both partnering and non-partnering projects and (iii) control for other variables that affect cost and quality in order to extract the unique effect of partnering. The existing partnering evaluations, divided into surveys, case studies and comparative studies with many observations, does not fulfil all three conditions. Instead partnering should be evaluated by a quasi-experiment or with a regression analysis and focus on quality and cost, the two variables that creates value.

Keywords: Evaluation, Partnering, project success, quasi-experimental methods, regression analysis.

1. Introduction

The overwhelming part of the partnering literature is of optimistic nature. This can to a large extent be explained by the extensive amount of consultant literature with the purpose of selling the concept. More scientific work has also provided theoretical arguments in favour of partnering accompanied by empirical papers most often showing positive results. Voices have been raised to approach partnering in a more critical perspective [1,2] i.e. to look at both advantages and disadvantages when investigating the phenomenon of partnering. This paper is an attempt to go in that direction and sets out to review partnering evaluations in construction managerial journals. It goes on providing principle suggestion for how these assessments can be improved.

2. How should partnering be assessed

In order to say something well founded about the effects of partnering in a construction project, three conditions needs to be satisfied. First, it should be based on project facts. Project facts are as objective as possible and do not include subjective declaration of about the effects of partnering. Second, the evaluation must include a comparative analysis. To draw conclusions about the effects of partnering, these effects have to be compared to non-partnering projects in order to analyse if partnering has improved the outcome. Last, other affecting variables must be controlled for. Since construction is a complex area with many variables that affect the outcome of a project, it is hard to extract the unique effect of partnering. In order to do so other variables have to be controlled for, i.e. ceteris paribus analysis. This can be done in different ways e.g. by statistical methods or by pair analysis.

3. What has been said and done

The existing empirical evaluations of partnering can be divided into surveys, case studies and comparative studies with many observations. None of the categories fulfils all the above conditions for good evaluations. The surveys are based on questionnaires about people's views and do not include a comparative analysis nor a control for other affecting variables. Case studies have a better chance of fulfilling the project fact condition as in-depth interviews are used. However none of the studies makes any comparative analysis nor has the ability to control for other affecting variables. The comparative studies with many observations obviously make a comparative analysis but lack in project facts since they are based on questionnaires and does not control for other affecting variables.

4. Improved assessment methods

Two methods have the potential of fulfilling the conditions. The classical experiment takes a random sample of people/objects and then randomly divides them into two groups. One of the groups get some kind of treatment (treatment group) but the other does not (control group) and conclusions can be drawn whether the treatment caused an effect. Often when wanting to evaluate some social programme or policy the evaluator does not have the privilege of getting to draw randomized samples to compare. Instead the treatment group is given, it appears "naturally" in society. Under such circumstances it has been suggested that the quasi-experiment can be suitable for evaluation. The problem is then to find a match as good as possible to the predetermined treatment group concerning all relevant independent variables except the one you want to study. If matching is done in a satisfactory way the study fulfils the condition of controlling for other affecting variables.

Another way of satisfying the above conditions when studying the effects of partnering is to apply a more statistical approach. Instead of finding a “completely” matching control group, differences are accepted and the strategy is to control for the effects of the other factors by using statistical techniques. In its simplest form, a linear regression model that fulfils the CLM-assumptions (classical linear model) allows frequentist statistical inference to be drawn. In other words, a model can be constructed with variables explaining e.g. cost overruns in construction projects. Including a dummy variable for partnering generates an estimate for the unique effect of partnering on cost, holding all other variables constant. Just as in all empirical analysis, the regression analysis requires good data in order to draw conclusions and since the sample is randomly drawn, the method also satisfies the condition for a comparative study.

5. What should be measured – a revision of project success

Two methods that improve partnering evaluations have been presented but the question remains on what should be measured. This is usually answered by the definition of project success, which in most cases includes time, cost and quality. Here an argument is made that time is only important if affecting the net present value of an e.g. infrastructure investment. The NPV is based on cost and quality. If for example one sub-contractor is five weeks ahead of schedule but his colleague, working on an independent assignment, is three weeks late the first contractors good work is unimportant as it does not affect the duration of the project.

5.1 Defining cost, quality and time

Cost and quality is defined as conforming to the procured price and quality level i.e. cost growth and conformance to requirements. Problem can arise when prices are inefficient, i.e. dumped or the contracted level of quality is too high/low. A way of handling this problem is to analyze the procurement situation. Given that time is measured by meeting schedule it will always affect the net present value.

5.2 Measuring cost, quality and time

A formal follow-up concerning the outcome of cost, quality and time in comparison to budget, contracting documents and schedule can be considered direct measurements of a project. In order to check that the initial level of the measurements is efficient a further analysis must be added. When direct measurements of cost and quality are not available, indicators of these are suggested to be the next best thing. The indicators should be seen as areas to study in order to form an opinion on their effect on cost or quality. It is suggested that contract flexibility, additional work and disputes have an effect on cost and quality.

6. Conclusions

This paper has exposed flaws in the bulk of current partnering evaluations and provided improved methods. The regression analysis and the quasi-experimental approaches are suggested as well-founded methods to evaluate partnering, as they handle the problems of comparativeness and other affecting variables when measuring the effect on cost and quality. These two measurements are the most important since they create value, while time should be included if it affects the net present value. Indicators of the measurements are required in order to control for efficiency and since data sometimes are hard to find. This analysis should focus on contract flexibility, additional work and disputes should work. It should also be acknowledged that partnering in a longer perspective might have some effects besides cost and quality. These effects are intangible and aim at making the industry more attractive and appealing to young people. How to conduct such a study has not been addressed in this paper.

References

[1] Green, S D (1999) Partnering the propaganda of corporatism. *Journal of Construction Procurement*, 5(2), 177-186.

[2] Bresnen, M and Marshall, N (2000) Building partnerships: case studies of client-contractor collaboration in the UK construction industry. *Construction Management and Economics*, 18(7), 819-832.

The Singapore brand name in international construction

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The construction industry in Singapore has secured large volumes of work in countries in South-East Asia, and in China, India, the Middle East and Central Asia. This is often attributed to "the Singapore brand name" which gives the firms a competitive edge. This "brand name" must be identified and properly defined to enable firms to take greater advantage of it. This paper reports on a study which investigated the root of "the Singapore brand name" with reference to international construction. It is based on interviews of senior practitioners. It is found that the brand name is real. Action is required to develop the brand name further, and to shape it to respond to changes in the overseas markets of Singapore construction firms.

Keywords: branding, export performance, country factors, firm factors, further development

1. The research question

This study sought to find out whether: (a) engineering and construction (E&C) firms derive special competitive strengths from features of their countries of origin; (b) E&C firms are distinguished by identifiable factors relating to their home countries; and (c) there is "a brand name" for Singapore E&C firms from which they derive competitive strengths and advantages. The objectives of the paper are to: (1) explore factors which have contributed to the strengths of Singapore firms overseas; (2) determine the weaknesses of the E&C firms; and (3) establish whether there is a Singapore brand name for E&C firms, and if there is one, suggest measures for developing the brand name and building upon it.

The 22 interviewees were Chief Executive Officers or Senior Managers of building firms, design firms, quantity surveying firms and financial institutions. Also interviewed were the Presidents of three professional institutions and trade associations, and Senior Managers of statutory boards promoting construction exports.

2. Singapore brand name

Cuervo and Low [1] urge Singapore transnational construction companies to guarantee "the quality of works to foreign clients to maintain and enhance further the reputation of the firm and contribute positively to the Singapore brand name". What is the Singapore brand name with respect to engineering and construction? What are its sources? How can firms utilize it most beneficially? How can it be developed further?

Various national leaders have referred to "the Singapore brand name". The Minister for Trade and Industry, noted: "We should build on our good reputation in the world for reliability, integrity and competence. The Singapore brand name is a major asset we own in common" [2]. Deputy Prime Minister Dr Tony Tan said: Singapore should not waste the opportunity to "build on the very good brand name" it already has in Turkey [3]. President S.R. Nathan of Singapore considered "values based on the foundations of integrity, excellence and meritocracy" to be "well-associated with the Singapore brand name" [4]. A Minister of State noted [5]:

…one of our undoubted competitive advantages is our trustworthiness – it is a vital part of our Singapore brand ... When I met officials in Hyderabad, India, they were very keen for our Singapore companies to develop townships there. They told me that with Singapore, they know they will get what they contract for – not just the physical buildings but value and no elastic extension of completion time…Our Singapore name is held in such high regard, that it is becoming a trusted reference used by many other countries and companies...We should thus guard this… brand name jealously as it is a competitive attribute that cannot be easily commodotised like widgets or copied like tax incentives.

3. Conclusions, recommendations

The study showed there is a Singapore brand name which contributes significantly to the competitiveness of its E&C firms. The sources of this brand name are: (i) the overall reputation of the nation in terms of its government and people; (ii) the national policy and regulatory regime which influences the practices and procedures of the firms; (iii) the volume, types and quality of the national stock of buildings and infrastructure; (iv) the track record of the E&C firms at home; (v) special niches the E&C firms have developed which are peculiar to the country; (vi) the firms' performance at home; and (vii) the firms' performance and reputation on projects they have undertaken abroad. From this study and the relevant literature, it may be concluded, at the broad level, that "the country makes the construction firm".

The study also identified several weaknesses in Singapore E&C firms. For example, there are collective weaknesses from the national E&C brand name, considering the same features which constitute the brand, as well as gaps in the development of the domestic industry and market. A collective (national) brand name is not the only source of competitive strength for the individual E&C firm as it operates abroad. Moreover, each firm must take its own internal measures to benefit from the national brand name. Fourth, the brand name should be further developed to extend and to deepen it.

The Singapore E&C firms should contribute to the enhancement of the Singapore brand name through better firm performance on each project they undertake at home and abroad. The professional institutions and trade associations should also take concerted collaborative initiatives towards the continuous development and improvement of the brand name at the industry level. The government and the E&C industry should also identify and address the weaknesses which the Singapore firms face owing to the brand name.

Some contributions to the literature may be drawn from the findings. First, the 'total' strengths and weaknesses of the models of international business competitiveness such as Porter's [6] diamond framework are important. The elements in the models which are often highlighted, should be integrated to form one set of national characteristics, group of products, systems, expertise, and total solutions distinguishing the firms from a particular nation. The study shows that the reverse of the "spearhead strategy" proposed by Huovinen and Kiiras [7] is also true; factors which make a host country's E&C market difficult for foreign firms to penetrate may also provide the home firms with features which enhance their competitiveness overseas; these may combine to form a national brand name.

Further research is required. A framework for identifying the features of the brand name of a country's E&C industry is required. It would enable firms from the country to identify and build on their sources of strength, and firms from other countries to identify suitable business partners and allies. If similar studies are undertaken in other countries, the building blocks of a concept of international competitiveness of E&C firms based on a brand name can be developed. Studies on how a nation can brand itself from the E&C view may also be undertaken.

References

[1] Cuervo, J. and Low, S.P. (2005) Significance of internalization factors for Singapore transnational construction corporations. *Construction Management and Economics*, 2005, **23**, 147-162

[2] Yeo, G. (2002) Speech By George Yeo, Minister For Trade and Industry, at the Opening Ceremony of Osim Hq., 25 January. Agency for Science, Technology and Research.

[3] Li, X. (2005) Turkey keen to attract Singapore investors. *The Straits Times*, May 11, p. 20.

[4] Nathan, S.R. (2004) Speech by President S.R. Nathan at Temasek's 30th Anniversary Dinner, 2 November 2004.

[5] Lim, R. (2005) Address by Mr Raymond Lim, Minister, Prime Minister's Office, and Second Minister for Finance and Foreign Affairs at the NUSS New Alumni Dinner, 23 July 2005.

[6] Porter, M. E. (1990) *The Competitive Advantage of Nations*. New York: The Free Press.

[7] Huovinen, P. and Kiiras, J. (1994) Spearhead strategy for cross-border exports within building market of EES countries. In Warzawski, A. and Navon, R. (eds) *Strategic Planning in Construction*, Proceedings of the A.J. Etkin International Seminar on Strategic Planning in Construction Companies. Haifa, Israel, June 8-9, pp. 421-443.

A practical aspect of the impact of globalization on China's recent construction market openness

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The growth of China construction industry is amazing. The globalization forces trigger the inevitability of openness of construction market of China with the commitment of APEC (Asian and Pacific Economic Cooperation) and WTO (World Trade Organization). This study attempts to investigate the progress of the market openness by examining the new regulations on administration of international AEC firms and the tender awarding practice. The results reveal that the current hindrances of international AEC firms to access China's construction market from the legal and practical aspect still exist but the globalization implication urges the progress of the construction market openness both in legal and practical aspect.

Keywords: Globalization implication, Openness of China's construction industry, Legal environment, Tender awarding mechanism.

1. China's construction industry and its globalization tendency

In new millennium, China intends to create an investment environment with openness, fairness, transparency to attract international Architecture Engineering and Construction (AEC) firms as well as to direct indigenous AEC firms to venture in international markets. However, currently Chinese construction industry is partially open to foreigners. Under the globalization tendency, China's Construction market will open sooner or later. This study attempts to investigate the progress of the market openness by examining the new regulations and the tender awarding practice (Regulations on Administration of Foreign–Invested Construction Enterprises (Decree No. 113), Regulations on Administration of Foreign-Invested Construction and Engineering Design Enterprises (Decree No. 114), Regulations on the Management of Foreign-funded Urban Planning Service Enterprises (Decree No. 116).

China's construction industry is the world's second largest after the U.S, with total output value of RMB 1.3 trillion (US$151 billion) in 2000 [1]. China construction industry's growth is amazing. The annual output growth of the building construction segment was 11.64% in 1998-2001 and it is more than the annual GDP growth, 6.98%. If the Chinese construction industry continues to grow at 10-12% per annum in the years ahead, China's construction output is expected to increase to about RMB 5.8 trillion (US$700 billion) by 2015, overtaking the US construction market to become the world's largest construction market [2]. The booming construction industry calls for the global co-operations because that it is very unlikely for one country to excel or even be self-sufficient in the various construction components of finance, technology, management, material, and labour. With the commitment to WTO and APEC, the China's construction market would open sooner or later.

2. Current characteristics of accessing China's construction industry for international AEC firm, legal aspect

Ministry of Construction and Ministry of Foreign Trade and Economic Cooperation jointly issued Regulations on Administration of Foreign–Invested Construction Enterprises (Decree No. 113), Regulations on Administration of Foreign-Invested Construction and Engineering Design Enterprises (Decree No. 114) Regulations on the Management of Foreign-funded Urban Planning Service Enterprises (Decree No. 116) in last few years. These latest regulations depict the relevant legal entry hindrance as well as new enablers for international AEC firms.

For international AEC firms, Decree 113, 114, 115 contain the relevant articles for the requirements of certificates but with non-recognition of foreign professional qualifications. Article 12 of Decree 113, Article 14 of Decree 114 stipulate the total capital contribution of the Chinese party to a Sin-foreign equity construction/construction and engineering design joint venture or a Sino-foreign cooperatively construction/construction and engineering design joint venture shall not be less than 25% of the registered capital. Although the foreign parties are allowed to remain the majority ownership, the ownership percentage of Chinese party is still under dominated minority. Article 12 of Decree 113, Article 14 of Decree 114 stipulate the total capital contribution of the Chinese party to a Sin-foreign equity construction/construction and engineering design joint venture or a Sino-foreign cooperatively construction/construction and engineering design joint venture shall not be less than 25% of the registered capital. Although the foreign parties are allowed to remain the majority ownership, the ownership percentage of Chinese party still has some limitations for ensure its dominated minority.

3. Current characteristics of accessing China's construction industry for international AEC firm, practice aspect

The most common method of China's competitive bids practice is the multiple criteria tender assessment methods (according to "Law of Bidding and Tendering" (National People's Congress,2000) and "Regulation on the committee and methods for evaluating bids"(National Development and Reform Commission, State Economic & Trade Commission, Ministry of Construction, Ministry of Railway, Ministry of Communications, Ministry of Information Industry, Ministry of Water Resource, 2001)) This is because the evolution of construction cost system is in the line with China's transforming from the purely planned economy to a market-oriented system within a socialist context.

The multiple criteria bid evaluation method includes the tender price as one of the criteria [3]. In summary, with the considerations of the contracting scope limitations for various entry modes, there is the different practice in China for awarding construction contracts: lowest tender awarding for wholly ownership foreign contractor, multiple criteria subjective contractor selection system for domestic contractor. The multiple criteria tender evaluation method reflects the China's characteristic, partial competition instead of full competition of China's construction industry. The lowest tender price could be invalid if the difference between the benchmark tender price and the bid price is more than 5%. As many small or medium size state-owned construction companies have no competition strength, therefore, removing some competitive tender prices is protecting for local construction companies. Exception is some projects funded by international organizations. For example, the Lubuge hydraulic power station project sponsored by the World Bank attracted five international contractors including two Chinese contractors to tender. Ultimately, Japanese contractor, Taisei Construction Cooperation won the project because of the lowest price [7].

4. The movement to the inevitability of the openness of China's construction market under the globalization tendency

The commitments to the WTO and APEC to open the China's construction market have some legal and practical reflections in this tendency. In the line with nation treatment of WTO, new regulations (Decree 113,114,115) removed the old limitations of "enterprises which foreign equity retain majority ownership shall undertake the same percentage foreign contracting business" in the old regulation. As part of its WTO commitments, China agreed to permit wholly foreign-owned enterprises to expand the working scope by December 2006. The international practice, in recent years, the evaluation of tenders has transferred from being based solely on price to the inclusion of other factors. The current revolution of the China's multi-criteria subjective evaluation system to minimize the bias and select the most suitable but not the lowest tender price candidates are on the line with this tendency.

5. Conclusions

The discussion results of the legal and practical perspective of the openness of China's construction market under the globalization tendency appear to reveal:

- The current hindrances of international AEC firms to access China's construction market from the legal and practical aspect still exist.
- The globalization implication urges the progress of the construction market openness both in legal and practical aspect.

References

[1] US Department of Commerce (2000) Construction and engineering services, China. Washington: US Foreign Commercial Service.
[2] Priyadharshini Navaratnam(2002) "Building construction and engineering" Imprint Singapore : International Enterprise Singapore
[3] Gu, Z. G. (1997). "Bidding & tendering evaluation method." Comparative studies on bidding & tendering between China Mainland and Hong Kong, L. Y. Shen and C. L. Xu, eds., Tianjin University Press,Tianjin, China, 87–98.

Organizational culture of Turkish contracting firms

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Construction is an important part of global economy affected by and affecting all parts of the globe. However, little is known about the specific characteristics of the construction industry's culture and how it differs between countries. This paper reports part of the study performed within a major research project which has been carried out in collaboration with CIB TG-23 "Culture in Construction". One of the aims of this exploratory study is to measure the organizational cultures of contracting firms within the context of the Turkish Construction Industry. In the study, Cameron and Quinn's Organizational Culture Assessment Instrument (OCAI) was used to diagnose organizational culture of the contracting firms. A total of 723 professional from 107 firms rated their own organization's culture. The results provide empirical evidence of organizational culture of the contracting firms in Turkish Construction Industry.

Keywords: organizational culture, OCAI, Turkey, contracting firm

1. Introduction

The number of research studies focusing on the organizational culture in the Construction Management (CM) field is increasing steadily, however, Ankrah and Langford [1] mentions that the concept of organizational culture is only now beginning to attract interest. Despite the substantial amount of research demonstrating the importance of cultural issues in the construction industry [1],this young and relatively immature literature, where the level of theoretical abstraction is yet very low [2], is far from addressing all dimensions of the issue.

This paper reports part of the study performed within a major research project which has been carried out in collaboration with CIB TG-23 "Culture in Construction". The main stimulus of this exploratory study is to measure the organizational cultures of contracting firms within the context of the Turkish Construction Industry.

2. Nature of organizational culture

The concept of culture, originated in the field of anthropology with more than 160 different definitions [3], is one of the most elusive terms in the organizational studies [4].

Focusing on the relationship between the organizational culture and performance, Barney [5] defines the term as "a complex set of values, beliefs, assumptions, and symbols that define the way in which a firm conducts its business".

A number of researchers investigated the relationship between culture and various organizational aspects; however, there still is a need for more empirical research for a complete understanding of organizational culture; which constitutes the main purpose of this study.

3. Research design

Measurement of culture represents difficulties, particularly in respect of the identification of cultural groups and boundaries. This is further complicated by the nature of the construction industry in which projects are temporary and participants are subject to the values and beliefs of their employing organization, professional groups and project organizations.

In order to be compatible with the studies conducted in other countries participating in the CIB TG23 research, Cameron and Quinn's [6] "Competing Values Framework" (CVF) as well as their measurement tool named "Organizational Culture Assessment Instrument" (OCAI) are adopted as the conceptual paradigm for analysis in this study.

3.1. The competing values framework

The CVF is based on two major dimensions and four main clusters. The first dimension emphasizes the organizational focus (internal versus external), while the second one distinguishes between the stability and control and the flexibility and discretion. Cameron and Quinn [6], identifies four quadrants, each representing a different set of organizational culture orientation: (i) clan, (ii) adhocracy, (iii) market, and (iv) hierarchy. Theoretically these all four cultural types exist simultaneously in all organizations; therefore archetypes may be used to describe the pattern of the organizational culture [7]. In order to diagnose the dominant orientation of an organization, Cameron and Quinn [6] developed an instrument known as OCAI, which consists of six different questions which are relevant to the key dimensions of organizational culture: (i) dominant characteristics, (ii) organizational leadership, (iii) management of employees, (iv) organizational glue, (v) strategic emphases, and (vi) criteria for success. Each question has four alternatives representing different cultural orientations making a total of 24 questions [6].

3.2. Sampling and data collection

Unit of analysis for this study is the contracting firms in the Turkish Construction Industry. A number of 265 firms were contacted, and only 107 of them- including the 12 largest contracting companies in the industry- participated in the study, giving a response rate of 40.38. A total of 723 individuals from 107 firms involved in the study representing different managerial and non-managerial levels.

Data were collected through a questionnaire survey divided into two main groups. Section A consisted of questions identifying ecological factors such as firm age, firm size, client type, etc. This part of the questionnaire was directed only to the executive managers of the firms participated in the study. Based on the OCAI, section B focused on the organizational culture of the firms. In this section, all respondents were asked to rate their organizations' culture on a 5 point-Likert scale. Overall culture of each organization is calculated by finding the average score of all respondents from the organization.

4. Analysis of the results

The results show that "hierarchy" is the most frequent (43 %) culture type in the sample, while the other internally-focused culture type in the framework, clan culture, is the second (35,5%) appearing one. The least emerging culture type is the "adhocracy culture" (7,5%).

Focusing on the strength of the dominant culture type in the sampled organizations, which is related to the number of points assigned to each culture type; it is found that clan (3,62) and hierarchy cultures (3,66) have almost same scores, in other words have the same strength. Findings revealed that no significant differences existed among the scores of different age, size, market or client groups.

Except for dominant characteristics, which emphasized the market culture, all dimensions of organizational culture seem to be in line with the overall organizational culture profile of the sampled organizations, dominated by clan or hierarchy cultures. This finding indicates the existence of cultural congruence in the sample, which is supposed to be positively related to the organizational performance [6].

The findings presented here indicate that the companies in the Turkish Construction Industry; (i) are result oriented, where people are very competitive, (ii) have a leadership style that exemplifies coordinating, organizing and smooth-running efficiency, (iii) have a management style which is characterized by team work and participation, (iv) are organizations where commitment and mutual trust is high, (v) emphasize permanence and stability, and (vi) define success on the basis of efficiency, where dependable delivery, smooth scheduling and low-cost production are critical.

References

[1] Ankrah, N.A. and Langford, D.A., (2005) Architects and Contractors: A Comparative Study of Organizational Cultures, Construction Management and Economics, vol. 23(6), pp.595-607.

[2] Rooke, J. (1997) Developing a More Emprical Approach to Culture, Attitude and Motivation in Construction Management Research: A Critique and Proposal, Journal of Construction Procurement, vol: 3(2), pp.45-55.

[3] Kroeber, A.L. & Kluckhon, C., (1952) Culture: A critical review of concepts and definitions, in Papers of the Peabody Museum of American Archeology & Ethnology, vol:47(1), Harvard University Press, Cambridge, MA

[4] Senior, B (2001) Organizational Change, Prentice Hall, New Jersey.

[5] Barney J.B., (1986) Organizational Culture: Can It Be a Source of Competitive Advantage, Academy of Management Review, vol. 11(3), pp.656-65.

[6] Cameron K.S. and Quinn R.E., (1999) Diagnosing and Changing Organizational Culture, Addison-Wesley Publishing, New York.

[7] Paparone, C.R., (2003) Appling the Competing Values Framework to Study Organizational Subcultures and System-Wide Planning Efforts in a Millitary University, Unpublished PhD Thesis, The Pennsylvania State University.

Cost allocation forecasting models for execution of different types of construction projects

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Economically, very significant phase in the life of each construction project is its execution. This is why a need arises for knowledge of cost allocation during the construction phase. The paper will analyse several dozen executed construction projects, distinguished by the type of facility; the database consists of executed buildings, tunnels and motorway sections. Statistical processing of the database will show a certain pattern in respect of cost allocation over time, depending on the type of the executed facility. Based on regression analysis and the pattern observed, a cost allocation forecasting model has been defined for each of the three facility types from the database. The research results are displayed in the form of regressive mathematical expressions and the accompanying graphics.

Keywords: construction project, time, cost distribution

1. Introduction

Research of cost allocation over time in construction projects represents a current topic in which a part of the research is focused on analysing the pattern of relations between these variables during the early stages of the project, i.e. examining the possibilities of applying the S-curve in the area of certain activities and problems.

Insight to the practices and review of the existing research shows that there is no methodology in Croatia suitable for modelling of variant forms of relations between costs and time in construction projects or the associated adequate approach to management of the risks contributing to significant exceeding of the originally planned costs and deadlines.

2. Current status

Construction project management includes planning (determining the goal) and control (comparing the works actually performed in relation to the plan). Various methods are used for planning and control, which should often be applied because the conditions of a construction project vary constantly, and a special role should be assigned to management of the finance because it represents one of the most important management functions. Cash flow management based on forecasting, control and updating is very important at both the company level and the project level, because the cash flow at the company level is actually the aggregate of cash flows of individual projects, while the financial estimates should be made in all phases during the project. When details such as the dynamic plan, materials declaration and cost schedule are available (containing the prices and quantities), the cash flow should be planned.

3. Database display

For better comparison and analysis, research was limited to collection of data, which could be classified into one of the three predetermined categories. The first category contains data on projects involving construction of buildings (ground floor + four floors). The second category comprises data on tunnel construction projects, while the third category contains data on civil engineering projects - construction of motorway sections (just the alignment, without the facilities). The projects covered by the research were performed in the period between 1991 and 2004.

The data on construction projects were collected via questionnaires and by interviewing the participants in construction – the contractors, supervising engineers and investors. The key elements in data collection pertained to:

- the agreed price of construction
- the agreed time of construction
- the actual price of construction
- the actual time of construction
- causes of exceeding the price of construction
- causes of exceeding the time of construction
- monthly collection of payments for the works performed

The data were collected via questionnaires completed by the investors, contractors or supervising engineers separately for each project.

Data for a total of 63 facilities were collected in 3 different categories:

- High-rise buildings,
- Tunnels, motorway sections,
- Alignment without the facilities

4. Assessment of database results for the buildings constructed

In this chapter, statistical database indicators for high-rise buildings, tunnels and motorway sections are described and presented.

Mathematical expressions for forecasting the s-curve on the basis of data collections are also defined. The time-cost relationship is defined for the actual situation and not the planned one, including or excluding the influence of risks, which is why two s-curves must be defined: s-curve Y' which includes the risks and s-curve Y which does not. In order to modify the Y' to form the Y s-curve, the data concerning the average modification of cost (Δv) and time (Δt) are used.

The polynomial curve of the displayed form proved best in this cases:

$$\hat{Y}' = \hat{\beta}_0 + \hat{\beta}_1 X + \hat{\beta}_2 X^2 + \hat{\beta}_3 X^3 + \hat{\beta}_4 X^4 + \hat{\beta}_5 X^5$$

$\hat{\beta}_0$, $\hat{\beta}_1$, $\hat{\beta}_2$, $\hat{\beta}_3$, $\hat{\beta}_4$ and $\hat{\beta}_5$ are estimated values of regression coefficients.

5. Conclusion

Data on 63 construction projects were collected. In respect of the type of facility, the projects are classified into three categories.

In addition to the basic data about the facilities – type of facility, time of construction, agreed and actual costs of construction, agreed and actual time of construction. Data was also collected about the monthly (allocated) costs of execution, based on which data was obtained for production of a time-cost curve for each of the executed projects.

Furthermore, data was collected about the risk factors and their impact on the final price of execution and the overall duration of construction. The results were obtained by interviewing various participants in the construction process (supervising engineers, investors, designers and contractors), who defined the type and intensity of risk impact during execution of construction projects.

References

Ashley, D.B, & Teicholz, P:M: (1977). Pre-Estimate Cash Flow Analysis**,** Journal of the Constr. Div., *Proceedings of the American Society of Civil Engineers*. 102(CO3): str. 369-379

Gates, M. & Scarpa, A. (1979). Preliminary Cumulative Cash Flow Analyis. *Cost Engineering*, 21 (6), str. 243 249.

Izetbegović J., Radujković M.(1995**).** An Expert System for Forecasting Trends in Projects Realisation Progress, SOVNET - INTERNET International Symposium "*Modern Project Management: Unification of Professionals for Individual Success*", St. Petersburg 14.-16. September 1995., pp 232-236

Navon, R. (1996). Cash Flow Forecasting And Updating For Building Projects*, Project Management Journal*, Vol. 27, No. 2, str. 14-23.

Radujković M., Izetbegović J. (1991) Izbor funkcionalnih veza kod istraživanja trenda S-krivulje, *4.jugoslavenski simpozij Organizacija građenja*, Građevinski institut Zagreb, Dubrovnik travanj 1991., Zbornik radova, str. 223-228

Radujković, M. (1993). Analiza utjecajnih faktora pri optimalizaciji roka građenja, doktorska disertacija, Građevinski fakultet Sveučilišta u Zagrebu.

Radujković, M. (1998). Izvor prekoračenja rokova i proračuna građevinskih projekata, *Građevinar*, Vol. 51, No. 2, str. 159 -165.

Radujković, M. (1999**).** Modeliranje toka novca u građevinskim projektima, *Ingmodel* 99.

Slaviček, R. & Radujković, M. (2002). Model for Cost Management in Projects of Road Construction, *Proceedings of international 2nd SENET Conference of Project Management*, Cavtat, Croatia, 2002., str. 436-442.

Performance indicators for international joint ventures: state of knowledge

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Establishing international joint ventures (IJVs) have become one of the most widely used strategies for construction companies to exploit business opportunities and expand their activities abroad. Despite their dramatic growth, achieving high levels of IJV performance is difficult in the construction industry. Although, motives, partner selection strategies, structure, benefits, risks and critical success factors for IJVs are extensively discussed in the literature, there is no agreed way of measuring performance. The aim of this paper is to critically review the findings of previous research on performance indicators. For this purpose, previous work is categorized according to the type of identified performance measure(s). Only an adequate combination of criteria may allow assessing the multidimensionality of performance, which requires an understanding of the links between performance at the project, IJV and each partner company levels. In order to bring together these different dimensions, a multi-dimensional performance indicator has been defined.

Keywords: International joint ventures, performance assessment, performance indicators.

1. Introduction

Joint ventures (JVs) offer a unique opportunity of combining the distinctive competences and the complementary resources of participating firms. Such combinations provide a wide range of benefits that neither participant might be able to attain on their own [1]. Through the formation of international joint ventures (IJVs), companies are able to exploit business opportunities and enter new markets abroad. However, the benefits associated with IJVs are counterbalanced by a wide range of problems. The failure rate of IJVs, in general, is high [2]. Since IJVs consist of three entities, such as two parents and the JV organization itself, these entities may have different goals, management practices and organizational cultures and it becomes difficult to manage these organizations and achieve critical success criteria. Yet, there is no consensus on how to define and measure performance in IJVs. In this paper, current state of knowledge on performance indicators will be discussed and a multi-dimensional performance indicator will be proposed.

2. International joint ventures

JVs have received a great deal of attention from researchers over the last few decades primarily because of their importance as a strategic alternative in global competition [3]. Although there is considerable amount of research in this area, assessment of JV performance has been problematic and efforts to identify variables associated with IJV performance have been constrained by disagreements regarding the comparability and reliability of alternative performance measures and methods [4]. A major difficulty in evaluating the success is due to the inability to define common performance measures which are valid for all IJVs.

2.1. Assessing the performance of IJVs

Measuring JV performance has always created difficulty for researchers because performance is a complex and multi-dimensional phenomenon. There are two main difficulties in evaluating the success of IJVs; first one is about deciding on whose performance should be assessed, namely the parent firms, JV itself or the operation/project and second one is about deciding on which measures to use as performance indicators.

2.2. Performance indicators

In their summary of prior empirical research, Geringer and Hebert [4] categorized extant studies into three groups depending on a variety of criteria used to assess IJV performance: financial indicators, objective measures and subjective assessment of satisfaction. Financial measures include various measures of profitability, growth and cost position. Frequently used objective measures include contract stability and longevity of the strategic alliance. Due to potential limitations and difficulties associated with the ability of financial and objective measures to reflect the real performance of IJVs, several researchers turned their attention away from objectivemeasures towards subjective measures of parent managers' satisfaction with IJV performance [3, 5, 6].

3. Performance measurement model for international construction joint ventures

In this research, an ICJV is defined as a new organization, which is formed between two or more construction companies from different countries to realize some common objectives through a construction project. Since construction industry has a unique nature among other industries, it is more difficult to define and measure performance in construction projects.

Within the context of this study, a performance measurement framework and a 3-dimesional construct are proposed to measure ICJV performance. These 3 indicators measure different aspects of an ICJV. "Partner performance" defines the organizational success of the partners; "project performance" describes the success of the project; and "overall satisfaction" indicates the level of perceptions of the partners about the JV.

Partner performance, which points out the organizational success, measures the extent the preset organizational objectives are realized at the end of an ICJV. Project performance is defined as the extent the predefined project objectives are realized. Overall satisfaction is the last indicator of an ICJV performance, which defines the degree of satisfaction of the parents with the JV and which is believed to provide a general idea about the success of the partnership beyond all financial and objective criteria.

The proposed multidimensional performance construct is supposed to reflect all the aspects of an ICJV, including the company objectives, project targets and degree of satisfaction, all of which may be considered as success indicators that measure the performance of an ICJV in each stage of the JV organization such as pre-formation, operation and termination.

4. Conclusions

Due to their increasing strategic importance in global competition, JVs have been receiving considerable attention from the researchers. Despite their synergistic effects, such international collaborative arrangements are very complex to manage successfully as far as the different and sometimes conflicting objectives, cultures and organizational structures of parent companies are concerned. So, it is not surprising that the failure rate of IJVs, in general, is high.

Evaluating the success of an IJV is difficult due to the disagreements on the definition and the measurement of performance. It is certain that to obtain a complete understanding of performance, researchers should use multidimensional constructs as performance measures. Performance of parent firms as well as the operational success should be measured. Similarly, long-term objectives should be considered in addition to the short-term objectives.

Within the context of this study, considering the unique nature of the construction industry, a conceptual performance measurement model is proposed and a multidimensional performance indicator has been defined. Three dimensions of performance indicator are the "partner performance", "project performance" and "overall satisfaction". However, the validity of the model and the performance indicator have not been proved yet, as the data collection process is still on-going and statistical analysis has not yet been completed.

References

[1] Makino, S., and Delios, A. (1996) Local knowledge transfer and performance: Implications for alliance formation in Asia. Journal of International Business Studies, 27(Special Issue): 905-928.

[2] Makino, S. and Beamish, P.W. (1998) Performance and survival of international joint ventures with non-conventional ownership structures. Journal of International Business Studies, 29:797-818.

[3] Killing, J.P. (1983) Strategies for Joint Venture Success. New York: Routledge.

[4] Geringer, J.M. and Hebert, L. (1991) Measuring performance of international joint ventures. Journal of International Business Studies, 22: 249-263.

[5] Lasserre, P. (1999) Joint venture satisfaction in Asia-Pacific. Asia-Pacific Journal of Management, 16, 1-28.

[6] Fey, C. and Beamish, P.W. (2001) Organizational climate similarity and performance: international joint ventures in Russia. Organization Studies, 22: 853-882.

Developing a business case to manage tacit knowledge within construction organisations

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Many companies are still reluctant to undertake knowledge management initiatives because of the difficulty in establishing a sound business case. In an effort to overcome this issue, this paper aims to provide some insights on developing a business case to manage knowledge in construction organisations. The paper aims to address this necessity by providing some insights on developing a business case to manage tacit knowledge in construction organisations. Understanding the need to manage tacit knowledge and awareness of benefits and value creation due to initiatives are considered to be important facets of a business case.

Keywords: Business case, Construction industry, Tacit knowledge.

1. Introduction

It is increasingly being acknowledged that Knowledge Management (KM) can bring about the much needed innovation and improved performance the construction organisations require[1]. As a labour intensive industry, the construction worker and their tacit knowledge has become more relevant to sustaining business performance than traditional physical capital. In the current business climate, there is a growing need for a clear business case for construction organisations to manage their knowledge. Although there is much said and written about the benefits of KM, not as much is written about making a business case for KM in construction organisations. The paper aims to address this necessity by providing some insights on developing a business case to manage tacit knowledge in construction organisations.

2. Knowledge management in construction

The term 'Knowledge Management' is relatively new to construction organisations, nevertheless, a growing number of organisations within construction industry [1] perceive KM as an integral part of their competitive strategy for providing long term benefits for the organisation. However, despite the interest and the effort put into KM by many leading companies, the discipline is still in its infancy in the construction industry and is at an embryonic stage in UK construction [2].

Different knowledge based solutions have been proposed in construction. As the construction industry is much centred on tacit knowledge and experience of construction workers, the industry is biased towards the process-view of knowledge. Hence, the process-based solutions enhancing personalisation strategies and interactions between construction workers, to generate and share construction knowledge, would be much more relevant to overcome KM problems in construction. The limited number of studies that have been conducted in construction focused heavily or solely on explicit knowledge [3] and on the role of information technologies [2]. Therefore, too often KM is limited to the appropriation and exploitation of explicit knowledge i.e. on codification strategies. Tacit knowledge or personalised strategy is either ignored or given less importance.

3. Knowledge worker in construction

What people do with their knowledge is the real driver for competitive advantage in the knowledge economy. Construction companies frequently claim that 'people as their greatest asset'. The increased awareness of the importance of employees' knowledge coincided also with a popularisation of the idea of the 'knowledge worker'. The importance of the construction worker is highlighted by the fact that industry relies on skill and on the capacity to bring different skills together effectively, thereby the concept of the knowledge worker has long been important to construction organisations. The fact that a great deal of the know-how required, for example, in an engineering project, is tied to knowledge that is not written in documents but realised through expertise and understanding of the project personnel, is not taken into consideration as a whole. Skills, experience and talent of construction workers, which account for tacit knowledge, are considered to be very valuable towards organisational performance due to intrinsic characteristics of the industry.

4. Developing a business case

A business case is essential if reassurance is to be provided to senior management, to motivate employees and to maximise participation and commitment to

KM. A business case is a structured argument put forward to senior decision makers to persuade them it is worth putting effort into developing KM. The details may vary from company to company, but they typically include a description of current challenges and the benefits of managing tacit knowledge, weighted against likely costs. From KM perspective, a business case is often seen as a document that presents a comprehensive view of the knowledge initiative(s) or project(s) and provides the financial justification for implementation [4]. The difficulty in establishing a business case for tacit knowledge management programmes is really an issue of cause and effect, and often stems from the fact that, since tacit knowledge is intangible, there is no direct link from a KM process to a demonstrable business outcome [5]. The clear connection between the KM and meeting business objectives is a prime requirement for a successful business case [6].

4.1 Understanding the need to mange tacit knowledge

There is much said and written on knowledge and its management, but tacit knowledge still considered to be relatively unexplored [3] and not fully understood as explicit knowledge. Hence, an understanding of what constitute 'tacit knowledge' is central to its effective management due to lack of understanding, specially within the construction industry. Yet, within the business context what matters is the understanding of how tacit knowledge is generated and utilised. There needs to be an accounting of the current status of any knowledge practices already occurring and in existence within the organisation. A knowledge audit identifies the expertise in the organisation, where it can be found, and how this expertise is accessed. It identifies what knowledge is needed to make decisions and what knowledge assets are needed in the future. Thereby, this could highlight the gap within the organisation in terms of tacit knowledge requirements. What is important for a business case is the necessity to manage tacit knowledge, whether it's a large or a small organisation.

4.2 Awareness of benefits and value

Justifying the benefits of KM initiatives constitutes as important part of any business case, however not easy. Justification becomes much more difficult for the management of tacit knowledge due to its intangible nature. Some of the benefits of KM will likely to accrue to the whole company, whereas others will accrue only to particular business units. The value of knowledge can be considered in two different ways i.e. micro viewpoint and macro viewpoint. It is required to first identify and separate the benefits of a given initiative, then determine its value to the firm, before proceeding to infer an associated cost and expected return for undertaking the effort. Clearly delineating the expected hard and soft benefits of each aspect of the initiative will greatly aid in effectively justifying its need.

5. Way forward

Although for many senior managers the logic for investing in KM is unquestionable and significant, it is important to develop a sound business cases to convince their sceptical management. As most of the construction organisations are still at the stage of building their awareness or understanding on tacit knowledge management, this will provide a valid basis and a systematic approach for organisations to follow, when developing a business case, and to move forward along the stages of the maturity model.

References

[1] Kamara, M J Anumba, J C Carrillo, P and Bouchlaghem, N. (2003), *Conceptual framework for live capture and reuse of project knowledge*, Construction informatics Digital library, available at http://itc.scix.net/data/works/att/w78-2003-178.content.pdf

[2] Carrillo, P.M. (2004), Managing knowledge: lessons from the oil and gas sector, *Construction Management and Economics*, Vol 22, pp 631-642

[3] Egbu, C., Kurul, E., Quintas, P., Hutchinson, V., Anumba, C. and Ruikar, K. (2003), *Knowledge production, resources and capabilities in the construction industry*, Work package 1-final report, Knowledge management for sustainable construction competitiveness project, Available from: www.knowledgemanagement.uk.net

[4] Sheehan, T. Poole, D., Lyttle, I and Egbu, C.o., (2005), Strategies and Business case for knowledge management, In: Anumba, C.J., Egbu, C. and Carrillo, P. (Eds), *Knowledge Management in Construction*, Blackwell, UK.

[5] Yelden, E.F and Albers, J.A., (2004), The business case for knowledge management, *The journal of knowledge management practice*, August 2004

[6] Palmer, J and Platt, S., (2005), *Developing a business case for knowledge management in construction,* insITe, Issue 3, May 2005.

Importance of KM for facilities management organisational effectiveness: intellectual capital perspective

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Although knowledge management concept has grown noticeably during last few years, management of facilities knowledge has been little studied. The research addresses the importance of managing facilities knowledge for organisational effectiveness from the intellectual capital perspective. Several existing gaps in terms of managing facilities knowledge were identified; the knowledge worker concept; evolving role and demanding skills of facilities manager; specific workplace related performance knowledge; recognition of feedback process; knowledge on customer requirements, and incorporated within different elements of the intellectual capital framework.

Keywords: Knowledge Management, Facilities Management, Intellectual Capital.

1. Introduction

The attraction of Facilities Management (FM) is becoming increasingly common, as forward-looking organisations are beginning to realise FM as a function with clearly defined objectives, and as a strategic and commercially orientated discipline. Yet, Knowledge Management (KM) has been little studied in the context of FM despite a theoretical proposition that it is one future [1], or perhaps the future of the discipline. As such, research has emphasised that there is a clear need to critically manage FM knowledge within workers, which would integrate both the business and facilities domains. The paper aims to highlight the importance and the relevance of managing FM knowledge for organisational effectiveness from the intellectual capital perspective.

2. Overview and underline trends of FM

FM, as one of the fastest growing professional disciplines, continues to expand and develop in terms of volume and diversity of commercial activity and appears to be gaining greater recognition and acceptance as a significant influence upon organisational success and goal achievement. FM is the process by which an organisation ensures that its buildings, systems and services support core operations and processes as well as contributing to achieve its strategic objectives in changing conditions [2]. Primarily FM was managed as an isolated activity and considered as an overhead like any other cost in the budgeting process. Yet, presently FM is managed as an integrated activity, integrated with the commercial, manufacturing and marketing function of the enterprise. The growing focus in FM definitions is to view it as management of non-core company assets and activities to support and increase the efficiency of the core business of the organisation. As identified by Nutt [2] there is a growing importance of managing facilities knowledge as a strategic resource in future.

3. KM application in FM context

The view that knowledge is a valuable organisational resource has become widely recognised and accepted in the business community. Discussions on knowledge emphasise two perspectives as identified by Empson [3]: ‘knowledge as an asset’ and ‘knowing as a process.’ On the ‘knowledge as an asset’ perspective, knowledge is often viewed as an objectively definable commodity, which can be managed and controlled by certain mechanisms. For ‘knowing as a process’ viewers, knowledge is a social construct, developed, transmitted and maintained in social situations. Whatever the perspective it takes, the management of facilities knowledge may be the most underutilised tool in KM [4] and such a knowledge perspective may supply the conceptual framework with which facilities users can understand and measure the business benefits they derive from such services. Thus, with the realisation of the strategic importance of people factor within FM organisations, there has been an increasing interest in the tacit dimension of knowledge, which is often embedded within human beings. Hence, people and knowledge trails have become the future opportunity within the strategic direction of FM. Thereby, it is synthesise that the application of KM within FM context needs to be focused on people aspects, and the intellectual capital framework is considered as an appropriate basis to manage such knowledge within FM organisations.

4. Intellectual capital framework

As McLennan [5] argues, the specific FM knowledge that has strategic value is the understanding of the relationship between the performance of the physical resources and their impact on the customer being served by these resources. Hence, this type of knowledge can be difficult to access since it is often tacit and experimental in nature. However, the intellectual capital framework provides an opportunity to deal with this area of knowledge.

4.1 Human capital

Different and frequently changing demands on the business requires the necessity for the employees to have the ability to adapt and apply their knowledge to solve new and challenging problems. Although much concern is devoted in corporate knowledge perspective, yet individual knowledge perspective is in the embryonic stage in FM. This has been highlighted by Nutt & McLennan [4] who contend that "initiatives for innovation in the individual's FM knowledge systems are hard to find." Facilities managers needs to value their entrepreneurial skills and knowledge of the core organisation, with the ability to pre-empt and translate the organisation's need for change into facilities strategies which underpin operational objectives to yield competitive advantage. The commitment from the people factor involved in FM organisations has a major role to play. For instance, evaluation of the efficiency and effectiveness of the existing building in terms of user satisfaction, identifying new improvements to buildings etc. are major roles of facilities managers. This stresses the importance and the necessity to recognise the concept of knowledge worker within FM organisations, which has gain increased concerns in other disciplines.

4.2 Structural capital

Corporate culture, company structure and business processes are those elements of structural capital that are difficult for others to duplicate. The processes that a company employs to conduct its business are usually specific and value to that organisation. One of the building blocks of KM is concerned with the identification of processes to help an organisation learn from its mistakes and to share best practices. One obvious benefit of KM processes is that it enables employees to quickly find an answer to a problem that has already been solved in another area of the organisation. In the commercial office sector, both the in-house and outsourced facility manager is poorly placed to exploit their tacit knowledge, due to lack of proper processes [5]. Knowledge is largely held by individuals and is only available to an organisation to the extent that effective processes are put in place to develop and share that knowledge and freedom and space is given to individuals to use their judgment and interpretation to apply that knowledge appropriately.

4.3 Customer capital

Understanding customers, managing their expectations and having a thorough understanding of the reasons why they brought to you, or have moved to a competitor, is worth measuring and tracking. KM initiatives can have a direct effect on customer capital returns. Organisations require the effective management of customers, assets and level of service- three related aspects of facilities operations. Managing customer expectations and meeting their requirements implies a total quality approach to developing and operating buildings and delivering support services to contribute to achieving business objectives. Recent experience in the management of non-core business processes consistently highlights a strong demand from customers for a more proactive approach to facilities strategy. This could be achieved with appropriate attitudes, improved processes and effective teamwork, all geared towards the customer.

5. Conclusion

The paper addressed the importance of managing facilities knowledge for the organisational effectiveness by considering the intellectual capital framework as the basis of identifying and recognising constituent variables of facilities knowledge. This provides a valid basis to empirically test the suitability of the intellectual capital framework in identifying and organising the facilities knowledge variables for organisational effectiveness.

References

[1] Nutt, B (2000) Four Competing Futures for Facility management, *Facilities*, Vol 18 (3/4), pp124-132
[2] Alexander, K (1996) *Facilities Management theory and practice*. Norwich: E & FN Spon.
[3] Empson, L. (1999), *The challenge of managing knowledge*, Financial times: Mastering strategy.
[4] Nutt, B and McLennan, P (2000) *Facility Management: Risks and Opportunities*. Oxford: Blackwell Science.
[5] Mclennan, P (2000) Intellectual capital: future competitive advantage for facility management. *Facilities*, 18 (3/4), 168-171.

A method to assess project success of international and local AEC firms in Tianjin, China

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This study aims to examine whether the project success of local and international AEC firms are different in China. Through literature review identifies 25 determinants of project success, namely, Critical Project Success Factors (CPFs) and indicators measurement of project success (KPIs). Six completed construction projects that involved three organizational forms (wholly owned entities (A1), local contractor (A11) and local designer (B11)) were selected to assess the international and local AEC firms' project success. MANOVA is adopted to model the relationships between categorical CPFs and metric KPIs for the measurement and evaluation purposes of this study. The findings reveal that international AEC firms have higher KPI value than the local AEC firms have.

Keywords: CPFs (Critical Project Performance Factors), KPIs (Key Performance Indicators), Entry modes, MAVOVA.

1. China's new construction market in millennium

The openness of China's construction market to foreign will allow both domestic and overseas AEC firms to compete under the same market conditions. Chinese government concerns whether the influx of the foreign AEC firms ameliorate current construction industry project success of China and how to learn from foreign AEC firms and nurture local AEC firms per se competitive advantages. This study aim to investigate whether the Project Success of various organizations of international AEC firms and local AEC firms are different in China; and what are the factors differentiate the Project Success of various organizations of international AEC firms and Project Success of local AEC firms in China.

2. Literature review

Prior researches have no consensus on the appropriate definition and measurement of the AEC firm's performances. This is because organizational performance is a controversial term. Researchers have been unable to resolve these issues theoretically, and little research has addressed organizational effectiveness empirically. The objective measurements in the literature evaluate the individual organization performance separately like using financial measurement in terms of financial profitability in the scale profitable(1), breakeven(0), or a loss(-1) [1]. Other subjective measurements like management satisfaction have this problem also. The longitude comparative study of the various organization performances is flawed if these individual and inconsistent indicators were adopted. In the project-driven construction industry, the KPI Working Group (2000) [2] proposed to use Key Project Indicators as the consistent benchmark to measure the various organizational performances throughout construction industry. In the literature, the project success measurement evolved from traditional iron triangle to multiple dimension, three stages, micro, macro point of view, and subjective and objective measurement. For the purpose of organizational evaluation, this study uses ten KPIs to compare the project success of international and local AEC firms. They are Construction time (K1), Speed of construction (K2), Time variation (K3), Construction Cost (K4), Unit cost (K5), Cost Variation (K6), Quality (K7), Functionality (K8), Client overall satisfaction rate for project success (K9).

Chan A.P.C. 2004 [3] conduced a through literature review for seven major journals in construction field for determinants of construction Project Success. He presented that the term Critical Success Factor (CSF) to Project Success in the context of management of project was first used by Rockart in 1982 and is defined as those factors predicting success on projects [4]. This study classified the determinants of Project Success into eight groups from C1 to C25.

3. Research method

The analysis tool is Multivariate ANOVA was used to test the hypothesis because the independent variables are non-metric and the dependent variables are metric scale. MANOVA is divided into three steps: the first step is to avoid violation of assumptions of MANOVA; the second step is to test hypothesis; the third step is to check the validity of the model, the last step is to provide recommends for further study.

This study employed three tests which are complementary to each other to avoid the violation of assumptions. Box's M tests, Levene's tests. and the spread vs. level plot for dependent variables for visual confirmation.

Simple contrasts using one level of organizational forms as the reference category (you may specify it as the first level) to compare the KPI values of second level with the first one to test the hypothesis that project successes of local and international AEC firms are different. If the significance value for one of the KPIs is less than 0.05, you can conclude this difference is not due to chance. If the significance value for one of the KPIs is greater than 0.10, so this difference may be entirely due to chance variation. The descriptive statistics part displays the each combination of factors in the model and shows the mean KPI values of the three organizational forms. It also gives out the effect of CPFs factors and the interaction effects of organization form and CPFs. Four commonly used test statistics for multivariate analysis of variance are displayed.

The estimated marginal means table displays the model-estimated marginal means and standard errors of KPI value at the factor combinations of organization form and C1-C25. This table is useful for exploring the possible interaction effect between these two factors. The profile plot is a visual representation of the estimated marginal means table.

Select Lack of fit to check if the relationship between the dependent variable and the independent variables can be adequately described by the model. In other word, it is for the purpose of check the model validity. Pillai's trace is a positive-valued statistic. Increasing values of the statistic indicate effects that contribute more to the model. Wilks' Lambda is a positive-valued statistic that ranges from 0 to 1. Decreasing values of the statistic indicate effects that contribute more to the model. Hotelling's trace is the sum of the eigenvalues of the test matrix. It is a positive-valued statistic for which increasing values indicate effects that contribute more to the model. Hotelling's trace is always larger than Pillai's trace, but when the eigenvalues of the test matrix are small, these two statistics will be nearly equal. This indicates that the effect probably does not contribute much to the model.

4. Results

The data results appear to confirm the original hypotheses.

The Project Success of international AEC firms and local AEC firms are different in China; Client experience (C2) (K2, K4, K5), Designer's times of and significant change orders variations (C7)(K5, K7), Contractor's working status (C11)(K2,K3,K8,K9), Building types (C13) (K1,K3,K4,K5,K7), Building work types (C14)(K9), Project size(C15)(K1, K2, K3,K4,K5,K7), Project complexity (C16)(K9), Project priority change and rework rate (C17)(K2,K4), Contract clause for claim due to the change orders (C19) (K2,K3,K4,K5,K7), Contract clause for payment (C20)(K7), Contract clause for programme(C21)(K2,K4,K5), Submissions for authority approval (C23) (K2,K3,K4,K5,K7), Inclement weather (C25) (K1,K2,K4,K5,K7) are significant factors that differentiate the project performance of international AEC firms and local firms. There are no CPFs have the interaction effect with the organizational forms. Chinese AEC firms may improve themselves in some aspects to achieve project success. The consulting and design construction firms may reduce the times of significant change order variations. The construction firms may enhance their construction capacity to avoid the defect error, problem and poor planning, especially poor project definition, perfectionism. When the AEC firms are drafting the contract clause for claim due to the change orders, the procedure should be comparatively simple. Contract clause for payment should be progress based and contract clause should have specific programme.

References

[1] Shige M. & Paul W. Beamish, (1998): Local ownership restrictions, entry mode choice, and FDI performance: Japanese overseas subsidiaries in Asia, Asia Pacific Journal of Management, VOL. 15, 119-136 (1998)

[2] The KPI Working Group (2000), "KPI Report for the Minister for Construction", Department of the Environment, Transport and the Regions, London, January 2000.

[3] Chan A.P.C. et al. (2004) Factors Affecting the Success of a Construction Project, Journal of Construction Engineering and Management Jan/Feb, 2004 PP 153

[4] Sanvido,V., Grobler F., Pariff K., Guvents M and Coyle M(1992) " Critical success factors for construction project", Journal of Construction Engineer Management, 118(1),94-111

The digital design for constructing architectural envelope elements

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The new potential introduced in architecture by Digital Design has caused a substantial evolution in the relationship between representation and planning. These innovations have had the strongest impact on the architectural envelope, which has become the vehicle for new forms of expressions, formally being a new way for designing a transformation, and for creating prototypes and generating the complex shapes of the envelopes, and in so doing architecture more and more frequently resorts to the software and procedures typical of other industrial sectors (i.e. automotive, aeronautic, and mechanical industries). The paper presents an experience aimed at assessing the possibility to produce non-standard architectural envelope covering shapes by means of the Incremental Forming (IF), an innovative system that is currently used in the automotive industry to make car parts.

Keywords: Incremental Forming, Digital Design, CAM, Architectural Envelope.

1. Communication and complexity

With regard to work organization, the new digital systems are a revolutionary event, since they allow us to put together all different phases of a project in a single process as far as the execution of the project, thus entrusting the architect/engineer with the real control of the works. In order to interpret and correctly use the contemporary technologies, a new approach is needed: these should not be considered as techniques available on the "standardization" market; instead, they should be taken as "customizable" techniques, thanks to the "mass-customization". In other words, the production of a special component at the same price as a standard piece. This has become possible thanks to the evolution of CNC machines, which are able to exploit data processed by software modifying their settings based on the components to be made. As for metal covering, state-of-the-art methods are now available, which can assure almost total flexibility.

2. Incremental forming

"Free-form" architecture has become more and more common in recent years, so as to almost form a new language. This architecture resorts to envelopes often made of metallic cladding panels, whose curvature reminds of cars' bodies. They often imitate the automobile industry.

The horse-head-shaped conference room of the DG Bank Building in Berlin by F. O. Gehry is covered with stainless steel plates. The composite curves of the horse head were built like a car body: A complex process was developed in order to produce in many different places moulds, formworks, stainless steel cladding panels, modeled according to final composite shape [1].

Obviously, this is a very expensive and time-consuming procedure, due to the several phases needed for the production. Instead, with the *Incremental Forming* (IF) the cladding panels can be made through a single phase, guided by a digital model, without resorting to moulds or frameworks. IF processes are carried out through a small and geometrically simple tool that moves according to an established trajectory, progressively deforming the semi-finished product, thus shaping it in compliance with the desired form [2].

The above considerations highlight the typical advantages and disadvantages of IF processes. First of all, these processes are by far more flexible than traditional forging: a wide range of totally different shapes can be obtained with the same tool, by modifying its relative motion. On the contrary, with traditional forging, a new mould must be produced if a different shape needs to be made. Obviously, this increases costs. In addition, due to the action exerted locally by the tool, the force necessary to obtain the deformation of the semi-finished product with IF is much lower than with traditional methods, which implies a much lower energy consumption, and less powerful-hence less expensive- equipment.

The so called *Single Point Incremental Forming* (SPIF) [3] certainly is the simplest and cheapest method, since no partial or total fixed punches are needed, as deformation is only induced by the tool that locally deforms the metal - which is firmly held along its perimeter - through a specific trajectory. Another fundamental feature is that the securing system is fixed, and contact between the metal and the tool occurs in the concave area of the component.

3. Testing

The above described SPIF process was the object of the tests we carried out at the "Fontana Pietro S.p.A." research lab located at the *Dipartimento di Tecnologie Meccaniche, Produczione e Ingegneria Gestionale* of the University of Palermo.

Figure 1. "Zang Tumb Tumb", H.S. Railway Station in Florence, project by Arata Isozaki.

A panel to scale was made reproducing a cladding panel of the envelope of the structure supporting the roof of the project "Zang Tumb Tumb" by Arata Isozaki (Figure 1) that was awarded second place in the contest for the projects concerning the High Speed Railway Station in Florence.

We used a numerical control EMCO PCMILL 300 milling machine with three controlled axles and the "Levels on Z" mode. With such mode, the tool moves along paths on planes parallel and orthogonal to the Z axle: hence, it works at constant Z level, and the trajectories on each plane represent the trace of the section of the piece with that plane. We started with 1.2 mm thick A6181 T4 aluminum sheets, and a C40 non-tempered steel, 5 mm radius, spherical bit tool. In consideration of the negative results we achieved in the first attempts, which resulted in the breakage of the semi-final sheet, we re-configured the model to be sent to the CAM. In order to diminish the sinking of the bit that provoked the stretching and thinning and subsequent breakage, we placed the panel onto some auxiliary walls. As the following images will show, the result was positive.

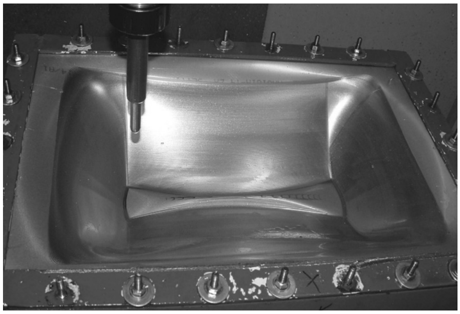

Figure 2. Final result, the panel (red boundary) is placed onto some auxiliary walls. We have used 1.2 mm thick A6181 T4 aluminum sheets, and a C40 non-tempered steel, 5 mm radius, spherical bit tool.

Another test was performed on a 1 mm thick stainless steel AISI 316 sheet. The test was negative: due to the friction, abrasion occurred between the tool and the metal. This was probably caused by the AISI 316 stainless steel tool, whereas a harder tool should have been used, which might have prevented such a significant abrasion.

Even if these results were obtained on a prototype, we demonstrated that a SPIF process can be a valid alternative to traditional forging techniques, also for complex shape components. The most relevant problems concern dimensional accuracy and the development of software for the realization of tool paths specific in architecture. Furthermore, contrary to what happens in the automotive industry, the materials used have mechanical features that significantly differ among one another: steel, aluminum, copper, titanium. For this reason, testing should be performed with these materials in order to obtain the information regarding the settings to be used for IF methods to be applied to the materials and thicknesses most commonly used in architecture.

References

[1] M. Friedman, D. Sorkin (2002) *Gehry architettura + sviluppo*. Rizzoli, Milano.

[2] F. Micari (2003) *Processi di formatura dei metalli, materiali e tecnologie*. Dario Flaccovio Editore, 2003..

[3] G. Ambrogio, L. Filice, F. Gagliardi and F. Micari (2005) *Three-dimensional FE simulation of Single Point Incremental Forming: experimental evidences and process design improving*. VIII International Conference on Computational Plasticity, E. Oñate and D. R. J. Owen (Eds), ©CIMNE, Barcelona, 2005.

Architectural freeform construction: Does the future start here?

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Next generation manufacturing technologies have the potential to drive the shift needed to achieve the changes the construction industry is being pushed towards. One class of these technologies, known as rapid manufacturing (RM) or additive manufacturing techniques (AMT), has the potential to impact on construction methods and may lead to radical change.

Keywords: Construction manufacturing; freeform construction, digital fabrication, rapid manufacturing, automation.

1. Future for construction

A major body of work at Loughborough University has explored available and proposed next generation Rapid Manufacturing (RM) and associated technologies from manufacturing industry, looking for solutions that could drive the way for innovation and deliver an alternative future for the construction industry (Buswell et al. 2005). Following on from this, the ArchiFORM research project was set the task of focusing on the more immediate solutions of applying RM processes and data capturing techniques to construction practices where 'cross–over' can be readily applied. Currently, architectural design makes wide use of computer aided 3D solid modelling (CAD/CAM) which provides digital visualisation and simulation. In addition to CAD there are two potential methods of capturing data digitally that can be used for reverse engineering (RE) construction elements: photogrammetry and 3D laser scanning.

2. Conventional technologies

In general conventional manufacturing technologies involve one, or a combination, of three basic approaches: additive, formative and subtractive. Construction also use these three approaches for varying aspects of the building works although overall the construction process are defined by Burns as additive (Burns 1998)

1) Additive – describes the process of adding material to build up the product, in construction this would be laying bricks, installing partitions, applying finishes etc.
2) Formative – describes the process of forming the product through the use of moulds. One example in construction is in-situ concrete work.
3) Subtractive – describes the process of forming the product by removing material through cutting, milling or grinding - an example might be cutting to size and shape stone, timber or sheet metals.

3. RE\AMT technologies

RE\AMT gives a fully automated process which uses computers for the design, the control of systems and machines and the construction or manufacture of parts

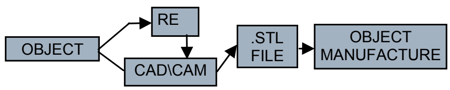

Figure 1: Digital process

3D laser scanners were used for the reverse engineering applications, either:

- A mobile arm device suitable for non-contact measurement applications either on site or at a studio or
- A static 3D plane and rotary static scanning device that scans as many as six different planes to capture side cuts and cavities

Software is able to take a polygon solid and automatically convert it to a NURBS file that can then be exported as an IGES file to industry standard MCAD Software.

Rapid Prototyping processes work by adding layers of material to build up three-dimensional objects, hence the term additive. It is the belief of many people that this Rapid Prototyping will eventually move into the heart of the manufacturing process and end use parts will be made directly by these techniques (Hopkinson, Hague, & Dickens 2005). This area has become known as Rapid Manufacturing or Additive Manufacturing Technologies.

To differentiate, the process is called Rapid Manufacturing if the product is put to direct end use, Rapid Prototyping if the product is used for conceptualisation, testing, analysis but not as an end product. Rapid Tooling is when the product is used for tools and moulds or as a pattern from which a tool can be formed around.

There are many AMT which exist and are emerging but these are commonly classified into six basic techniques available for making the part or prototype (Noorani 2006), these are:

1) Stereolithography (SL or SLA) – uses photosensitive resin cured by laser
2) Laser Sintering/Fusion (LS or SLS) – applying an IR laser to melt or sinter a powder based material
3) Fused Deposition Modelling (FDM) – generates 3D models using extrusion
4) Laminate Manufacture (LM or LOM) – Trims or cuts sheet material to correct size which are stacked and bonded into a solid block
5) Jetting (MJM) – Inkjet printer arrays apply polymeric materials where required
6) 3D Printing (3DP) – uses dual ink jet printing heads to deposit binders onto powders to build up the part

4. ArchiFORM research

Loughborough University is combining the expertise from Construction Management and Rapid Manufacturing within the Innovative Manufacturing and Construction Research Centre (IMCRC) at Loughborough and has given rise to the Freeform Construction Group (Freeform 2005) which is exploring the feasibility of using Rapid Prototyping systems within the construction industry now and in the future in what it calls “freeform construction”.

The current ArchiFORM research project is investigating direct market applications such as the repair and replication of elaborate features that are no longer in production. Architectural plasterwork parts were directly produced for Troika Architectural Mouldings, without the need for moulds. For larger quantities, moulds can be produced using Rapid Tooling technology omitting the need for time consuming and expensive hand moulding and/or sculpting. An alternative use for this technology has been identified and tested for Cradley Special Bricks who manufacture a range of architectural feature bricks and have a substantial market in replacing worn and decayed feature bricks.

The traditional production method requires moulds to be made by hand from the existing bricks which then need to be scaled up in size to allow for shrinkage of the clay during firing. The use of reverse engineering to produce the moulds again removes many time consuming activities and allows the CAD and Rapid Tooling process to eliminate errors in the detailing and scaling of end product. Future outputs from this project include an evaluation of applicable ready to market processes for construction manufacturing, cost models and anticipated future developments.

5. Conclusion

Rapid Manufacturing technology has the potential to create a new type of construction industry, it can be seen that the change will be radical when it arrives and instead of being used to make models for visualisation, it could be used to create full scale buildings. Current applications are being found in small part manufacture particularly those from the ArchiFORM project and those that require low-volume, high-value items such as heritage and fine art. In the future Freeform Construction might allow us to ‘print’ buildings, as if you were printing this page. To combine the whole design, construction and maintenance process into a seamless operation and to produce structures and components which meet the challenges of our changing world.

References

1.Burns, M. (1993) Automated Fabrication, Improving Productivity in Manufacturing, PTR Prentice-Hall, Englewood Cliffs, New Jersey.

2. Buswell, R. A., Soar, R., Pendlebury, M., Gibb, A., Edum-Fotwe, F., & Thorpe, A. 2005, "Investigation of the potential for applying freeform processes to construction", in Proceedings of the 3rd International Conference on Innovation in Architecture, Engineeing and Construction (AEC), pp. 141-150.

3.Freeform (2005) http://www.freeformconstruction.co.uk/index.htm

4. Hopkinson, N., Hague, R. J. M., & Dickens, P. M. 2005, Rapid manufacturing: an industrial revolution for the digital age, John Wiley & Sons, Chichester.

5. Noorani R; Rapid Prototyping – Principles and Applications; John Wiley and Sons; 2006

Project finance and hydropower projects: a case study of Birecik dam and hydroelectric power plant project in Turkey

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Hydroelectrical power projects pose particular difficulties compared to other infrastructure projects due to their capital intensive nature, high construction and hydrological risk, and associated environmental concerns. Combined with specific issues related to BOT model, the implementation of such projects become more complex for the parties involved. This paper aims to introduce Birecik Dam and Hydroelectric Power Plant which is the first major hydroelectric power plant realised on a BOT basis in Turkey. The challenges related to the implementation of BOT model, the way these problems are dealt by participants, principles of evaluation, total investment cost and project schedule, social and environmental sensitivities, relationships between unpredictable quantity of output and offtake agreement, public - private risk allocation, and financial structures will be analysed and strategies to overcome the obstacles will be recommended.

Keywords: BOT, hydroelectric power plants, case reports, Turkey

1. Introduction

Hydroelectric power projects are capital intensive investments that require high initial investment costs and long construction periods. They are characterized by high risks related to dam construction, variable output dependent on river flows, environmental concerns and social impacts. On the other hand, advantages such as long lifetime, lower negative environmental impacts compared to other energy resources, low operating and maintenance costs as well as renewable, local and reliable nature of hydropower projects makes them strategically important worldwide [1],[2]. Birecik Dam and Hydroelectric Power Plant is the first major hydropower project to be financed on a BOT basis in Turkey. The aim of Birecik project is to use the waters of Euphrates river for power generation and irrigation. Birecik Company was granted an exclusive mandate in April 1989 by the Ministry of Energy and Natural Resources (MENR) to develop and operate the project under a BOT model. The implementation contract was signed in March 1993 and provided that the project is built and operated 15 years after completion by Birecik Company. At the end of this period the facility is to be transferred to MENR at no cost. The project was completed in October 2001. Special purpose company, Birecik A.S. comprises an international group of shareholders who in total hold 70% shareholding of Birecik Company. The state utility TEAS holds the remaining 30% of shares. According to the Energy Sales Agreement, Birecik Company sells electricity to TEAS for 15 years of operating period under a take-or-pay contract.

2. Financial structure

Total project cost is 2,262 million DM (app. 1,114 million Euro). Debt to equity ratio is 85/15. 44 banks from 10 countries agreed to underwrite the loan. 237.7 million euro of debt equivalent to 21 % of total project cost is commercial debt and remaining 709.5 million euro of debt equivalent to % 64 of total project cost is provided by the Export Credit Agencies (ECA). In a typical hydroelectrical power plant project, the portion of civil engineering work is relatively high, bringing about more possibility to use local finance[1]. Despite high civil work in Birecik, most of the debt is provided by ECA loans. By lowering associated project risks, ECA loans can increase the attractiveness of the project to commercial lenders as well as having advantages such as longer maturity periods compared to commercial debt.

3. Design, total investment cost and project timetable

The project was initially designed by a state owned organisation EIE (Electric Affairs Survey Administration). After the concession agreement between Birecik Company and the State had been signed, the final and detailed design were prepared by a shareholder in Birecik Company, Verbundplan. Construction consortium comprises of 3 groups; designer, civil works joint venture and hydroelectrical and mechanical consortium. All of the contractors in construction consortium are equity holders in Project Company. As an unusual application, in Birecik, significant amount of completion risk is born by Turkish Government. The project was completed on time and total investment cost was reduced from 2,262 to 1,925 million DM on behalf of MENR. Evidence to date suggest that such schedule and cost performance is not common in dam construction. Cost, time and output predictions have in general been under or over estimated. According to a survey of World Commission on Dams [3], over 81 large dam projects, almost three-quarters of the dams have resulted in capital cost overruns with an average overrun of 56% over predicted costs. Another survey on schedule performance points out that out of 99 dam construction projects almost half were behind schedule[3].

4. Evaluation of project

For economic analysis of the Project cost benefit ratio, internal rate of return (IRR), profitability index and employment-investment ratio are evaluated. In the feasibility report, socio-economic development benefits and costs of dam construction in the region were mentioned without taking place in calculations. The difficulty in translating social and environmental costs and benefits in monetary terms has been a major obstacle in decision making process as well as being the major source of conflicts. Traditional methods such as NPV, IRR, sensitivity analysis fall short in reflecting social and environmental impacts of projects. Therefore, until today decision making criteria has been to approve projects that were judged to have more gains than losses.

5. Risks and security

In Birecik project an important amount of risks are assumed by the public sector. Risk management envisage that risks should be allocated to those who are best able to manage them. In a hydropower BOT project the complexity of technical, economical, and financial issues favour such high risk sharing by the public sector. However, at the same time it creates a paradox for utilisation of BOT model: while shifting risks such as construction and exploitation to the concessionaire lies at the heart of BOT contracts, hydropower projects favour assumption of those risks by public sector as the case in Birecik.

6. Concluding remarks

- Overall performance of the project. Birecik Project was a success in schedule and technical performances. Unlike the hydropower plant construction experience to date, the project was completed with a cost underrun and without any schedule delays. Although total investment cost may be considered high compared to other hydropower plants with similar capacity, it should be noted that every hydro project is unique with different characteristics of commercial, financial, technical and country needs and risks.
- Project evaluation. A detailed feasibility study has been undertaken by the public sector taking into account the overall costs and benefits of the project. However, the difficulty in translating social and environmental costs and benefits in monetary terms remains as the major obstacle in evaluation studies not only for Birecik but for many other projects worldwide. This difficulty appears to be the main source of oppositions and disputes about dam and hydropower plant construction. For future projects there is a need for a more accurate decision making process in order to prevent the controversy and debate surrounding these projects.
- Offtake agreement. In hydropower projects, construction costs are subject to hydro-specific risks (e.g. geological conditions, flooding) and future revenue stream depends on uncertain water flow. Without a long term offtake agreement, the lender can choose to lend to a corporation rather than to a project with uncertain future income stream. Notwithstanding this, if the lender decides to provide debt for this project, then he will obviously reflect the high risk in the interest rates charged. Therefore, under a BOT model, it was crucial for Birecik Project to have a long term offtake agreement.
- Finance. Hydropower plant construction has higher initial capital needs compared to other forms of power generation combined with high transaction costs, relatively expensive EPC contracts and high contingencies. Raising finance is difficult for such a large-scale hydropower project. Notwithstanding this, if the necessary debt is provided, there will still be issues related to tenor of loans and interests. Despite the difficulties, it is crucial for parties involved in a hydropower BOT project to find new ways of raising longer-term finance that match with the long plant life in order to prevent high tariff price in the early years.
- Risk allocation. In Birecik Project, substantial amount of risks are born by public sector. Although support and risk assumption by the government is important for technical and financial viability of the project, it contrasts with the risk-sharing concept of BOT finance. (ie. Completion risks are born by public sector for Birecik Project). There is a need to optimize risk sharing mechanisms so that the utilisation of BOT model is favorable over other financing models that are being used in the Country.

References

[1] Head C.L. (2000) *Financing of Private Hydropower Projects,* World Bank, July 2000

[2] Cappellini G. (2005) *Il Project Financing nel settore energia*, Economia e diritto del terziario, anno 17 n.1: Finanza di progetto problemi e prospettive, Francoangeli, Milano

[3] Asmal K. et.al. (2000) *Dams and Development: A New Framework for Decision-Making,* The Report of the World Commission on Dams, Earthscan Publications Ltd, Lo

Risk management supported by risk register

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One of important problems in construction is poor and inadequate dealing with risks in construction, so most of practitioners were usually surprised by the risks. Many project managers are suffering from absence of adequate information, even they passed trough similar challenges and situations in the past projects. Therefore we proposed development of simple and easy for use risk register which can facilitate process of risk management in construction projects. Risk register can be applied as a supportive tool while developing strategy and dealing with risks in construction project. The paper describes main ideas about structure and use of the proposed risk register.

Keywords: risk management, risk register, structure design, tools, construction.

1. Introduction

The purpose of investment project is to increase value, whose uncertainty is directly related to uncertainty of events effecting final result. The fact that unmanaged and unmitigated risks are one of primary causes of project failure makes risk management very important part of project management.

Today, risk management in construction is acknowledged as a very important part of project management and a very interesting subject to write about as well. It is frequently discussed, but the practice is still at an inadequate level. Reasons vary from case to case, from the lack of knowledge to implementation of risk management, or the lack of resources. However, the reasons are mostly related to a poor knowledge of risks per se. One of important findings of the research was poor and inadequate dealing with risks in construction, so most of practitioners were usually surprised by the risks. In the study conducted we found that many project managers are suffering from absence of adequate information, even they passed trough similar challenges and situations in the past projects. Therefore, our recent work aimed to come up with directions for a risk register structure design to be used in construction companies and risk management development through its implementation.

2. Risk register system

The model of the Risk Register System (RRS) consists of two parts, Project Risk Register (PRR) and Central Risk Register (CRR) (Figure 1). Project Risk Register enables recording and saving risk data throughout the whole risk management process in order to collect data for each construction project. This part has the role of a platform and tool for project risk management and communication. Providing continuous risk tracking it can become a medium for communication between project stakeholders.

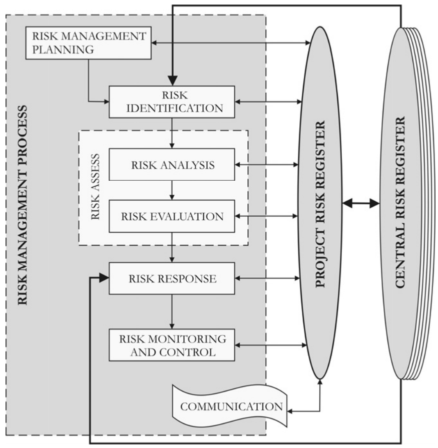

Figure 1 Model of Risk Register System

Risk data from all projects are stored in the Central Risk Register. This part of RRS has a function of "repository of knowledge". During long term utilisation it becomes a source for quantitative and qualitative risk data. It is especially valuable as risk identification tool and as a source of data on risk response, tracking and controlling, it enables particular response efficiency evaluation as well as undertaking a consequence-based action. For the CRR to fulfil all its functions it is necessary that the planned and actual data are compared and summarized in relation to risk "behaviour and reaction". The more data on changes causing modification of a risk component or characteristic exist, more reliable information and conclusion on sources and drivers can be obtained. A comparison of initial response plans and actual actions and consequences will enable risk management quality assessment and improvement.

Data and structure of PRR arise from the model of RRS and risk management process; therefore, they need to involve all risk components and characteristics through all the stages of risk management process.

3. Risk management with risk register

Many practitioners are substituting entire risk management process only with risk identification or risk analysis omitting other stages of systematic risk management process. PRR as part of RRS was designed to be a platform for all risk management stages providing the guidelines for systematic risk management, even in its lowest application level. Together with CRR designed as database, it comprises and quickly provides authentic data for the most important risk management tools such as: checklists, risk documentation form, risk classification, risk ranking, graphic representation of risk information, cost-benefit assessment, cause and effect analysis, risk mitigation plan, periodic risk reporting, risk time frame assessment, etc [5]. Only few of them will be presented later in the paper.

For the basic application of PRR it is necessary for each identified risk event to identify main risk components and characteristics – risk event, source, driver(s), consequence, character and time of impact, along with initial response actions and responsible person. With these information is possible to get basic documents for project risk communication. Even with these basic information is possible to perform cause and effect scenario analysis. Not all identified project risks are treated the same. Therefore, risk analysis and evaluation is done for each risk in which is calculated or estimated probability of risk occurrence and value of impact on the project. Combining these two values PRR calculates risk impact and acceptability. Based on risk impact value project risks can be ranked to provide valuable information which top 5-10 risk will be treated and risk acceptability will give the guideline for risk response selection.

Advanced application of PRR facilitates risk response cost-benefit analysis based on comparison of initial impact cost with response cost and cost from residual impact. Risks can also be ranked according to residual risk impact after applied response.

Saving these data in CRR it becomes a well structured source of information for risk management. CRR can provide information on key risk scenarios which cause negative consequences for specified type of projects. Searching for risks from similar projects, custom made checklists can be made for each project with the same characteristics. It is especially important for development of effective mitigation strategies. Based on actual (final) data on risk response from past projects it can provide information for selection of risk management strategy.

4. Conclusions

Proposed Risk Register System has major advantage because of its flexible structure which enables its application regardless of risk management level. It can be used in firms with advanced as well as in those with lower risk management practice and knowledge, supporting and directing progress in risk management practice towards complete application. An extension of application to CRR will result in creating a database of good and bad practice which will definitely contribute to the improvement of project management practice in construction. Successful risk management, therefore project management, depends on successful decision-making which is done based on information provided which have to be authentic and on time. Risk Register System is designed for systematically data saving and providing information for risk management to ensure successful decision-making.

References

[1] Kerzner, H (2003) *Project Management: a System Approach to Planning, Scheduling and Controlling, Eight Edition*, Wiley, John & Sons, 2003

[2] Radujković M. (1997) Risk Sources and Drivers in Construction Projects, *International Symposium PRM'97 - International Project Management Association IPMA, Helsinki 1997, E&FN SPON, London*, 275 - 284.

[3] Patterson F.D., Neailey, K.: (2002) A Risk Register Database System to aid the management of project risk, *International Journal of Project Management, Vol 19* , 139-145.

[4] Williams, T.M. (1994) Using a Risk Register to Integrate Risk Management in Project Definition, *International Journal of Project Management, Vol. 12, No. 1,* 17-22.

[5] T.Raza, E.Michael (2001) Use and benefits of tools for project risk management, *International Journal of Project Management, Vol. 19,* 9-17.

Pooling individual experiential narratives to enhance organizational learning

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Organizations use narratives as a means of influencing. However, alternative narratives seldom gain sufficient resonance to compete against dominant accounts. In this paper we argue that structured dialogue empowers alternative voices to merge. Through a structured dialogical methodology (the dialogue seminar) officials in a municipal urban-planning organization were enabled to articulate and share their experiences. The resulting collective stories generated strength to collectively voice demands for organizational change.

Keywords: Dialogue, narratives, resource pooling, learning, organizational change.

1. Introduction

Organisations use narratives as a means of influencing organisational activities and discourses. These narratives echo the voices of those in power, making them very difficult to contest or resist. Although alternative narratives exist, they seldom gain sufficient resonance to be heard above dominant accounts. Furthermore, alternative narratives remain transient since they are seldom documented. They travel by word-of-mouth nurtured by organisational subcultures.

To gain access to these alternative narratives, a variety of more or less structured tools have been developed. Most of these tools concentrate on the modality of speech and the stories told reconstruct events in retrospect [1][2][3][4][5][6]. To capture the dynamism of organizational meaning making as it is being made, it is essential that several modalities come into play in order for alternative voices to be engaged [7].

In this paper we examine how a collective alternative organizational narrative emerges and gains currency in an organization. It is the story of a bottom-up endeavor to elicit managerial change using a multimodal and dialogic approach, the dialogue seminar.

2. The Dialogue seminar

The structured dialogical methodology used in this study is based on close reading, reflecting, personalizing, writing, discussing and sharing [7]. The strength of the method lies in its use of several modalities and genres as mediating tools in the knowledge-creation cycle. Through these modalities, the four categories of knowledge – explicit and tacit, and individual and group knowledge – are fostered and given a chance to cross fertilize.

The seminar is led by a facilitator, who chooses a set of texts to base the seminar conversations on. These texts may serve as a stimulus for tapping into personal experience and generating new insights. Apart from the seminar facilitator, there is a recorder whose task it is to document the conversations.

A dialogue seminar cycle is composed of three phases: preparations, seminar and follow-up. The preparatory part entails reading the assigned texts and annotating whatever associations come to mind. These notes should then be related to one's own experience and developed into individual essays. In the seminar, each individual narrative is read out loud by the author while the rest of the participants listen and relate what they hear to their own experience. In this way, each reading generates reflection and dialogue.

In the follow-up part, the recorder's notes of the dialogues are reviewed by the seminar participants. The revised records as well as all the personal narratives are then "published" in a booklet and distributed.

3. The UP case

UP is the urban planning authority of a larger Swedish municipality. Formally the municipal council – the planning and building committee – commission work to UP. Typical assignments are establishing prerequisites for the planning of housing, infrastructure, industry, and city areas. Urban planning, both on a comprehensive and on a detailed level, involves a number of municipal authorities as well as politicians in the local government.

In connection with an in-house program at UP, we used the dialogue seminar to create a structured dialogic and inter-subjective forum for the sharing of experience. In their mission to "shape the city architecture" UP actors perceived that they were unable to make their voices heard. Their narratives tended to be muted, by those in power. The seminar was an attempt to create a collective alternative story.

4. Conclusions

The paper suggests that by pooling resources and using a structured dialogical methodology incorporating both oral and written modalities, alternative voices may merge into an instrument of change in the organization. The strength of the method lies in its use of several modalities and genres as mediating tools in the knowledge-creation cycle.
The UP case showed that it is extremely difficult to change the governing organizational practice and story from the shop-floor. The result was that the two different stories clashed, the governing story and the emergent alternative story. The governing story was that of problematic politicians and the domination of other municipal authorities. The new story of the course participants emerged through the dialogue between individuals who shared similar concerns. Through their dialogue they gained strength as individuals and as a group, but were unable to break the locks of the governing story.

The question that needs to be posed is to what extent the dialogue workshop may serve as a lever for the group to bring about organizational change. Does pooling of individual experiential narratives enhance organizational learning? Another important question is how an alternative narrative can be strengthened so that it may reverberate through the governing wall.

What did the organization learn? The management did read the essays and did in the end meet with the group which showed an incipient shift in attitude. Unfortunately, they at this stage had not reached sufficient maturity to take in and act upon the information they were given. Therefore the confrontation did not result in direct changes for the organization. At the same time the organization was in the process of recruiting a cohort of novices. We can only hope that the circumstances surrounding these recruits were improved.

What did the group learn? We think that the most important lesson the group learnt was to listen. Listening is one of the most difficult activities of our modern society. By listening to each others' stories the group also learnt that they were a group; that they shared similar experiences; that they shared a common language. The seminar provided them with a space for orchestrating their voices and making collective sense of their situation and that of the organization.
During the seven or eight months of different course activities and self-initiated meetings, the group had developed confidence and a strong team-spirit. However, in approaching management neither their voices nor their collective narrative gained sufficient resonance. Management was unwilling to enter into a dialogue with them. This evidently infused courage in several of the participants to change their situation on their own and leave the company. Those who remained felt that the experience had restored their sense of professional pride and we can only hope that this will enable them to stand up to future adversities. Those who left the company informed us that they were taking a valuable new tool for collective reflection with them.
What did we learn? As researchers (and in our roles as teachers) we were enriched by the stories both personally and professionally. These stories become part of our own repositories of discerning and pragmatic narratives, allowing us to tap into others' 'know what' and 'know how'. Also, with the blessings of their authors, these stories have been used in other dialogue seminars to trigger memories and awaken imaginations. To conclude, the most interesting lesson we learn, over and over again, is how well people can write about their personal experiences, and how extremely enjoyable these stories are to read.

References

[1] Gabriel, Y. (2000) *Storytelling in Organizations: Facts, Fictions, and Fantasies*. Oxford University Press, Oxford.

[2] Boje, D. M. (1995) Stories of the storytelling organization: A postmodern analysis of Disney as 'Tamara-land'. *Academy of Management Journal*, 38 (4), 997-1035.

[3] Boyce, M. (1996) Organizational story and storytelling: A critical review. *Journal of Organizational Change Management*, 9 (5), 5-18.

[4] James, C. & Minnis, W. (2004) Organizational storytelling. *Business Horizons*, 47 (4), 23.

[5] Abma, T. (2003) Learning by telling: storytelling workshops as an organizational learning intervention. *Management Learning*, 34 (2), 221-240.

[6] Isaacs, W. (1999) *Dialogue and the Art of Thinking Together.* Currency, New York.

[7] Göranzon, B., Hammarén, M. & Ennals, R. (2006) *Dialogue, Skill and Tacit Knowledge.* John Wiley & Sons, London

PPP financing, architectural design, and risk mitigation in Melbourne's Southern Cross Station project

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This paper will present a case study of Melbourne's $700M (AUD) Southern Cross Station Redevelopment (formerly known as Spencer Street Station), which is one of the largest PPP's in Australia to date. Intended for completion in time for Melbourne's Commonwealth games in 2006 the station is notable for the architectural design of its geometrically complex and innovative wave-like roof. Using this project, the paper's objective is to make evident the conjunctions of local and global issues inherent in the PPP model. To achieve this, the paper examines the linkages between the station's architectural design, construction innovation, project finance and the interrelationship of these in the context of the PPP lifecycle.

Keywords: PPP, architectural design, finance, public infrastructure projects.

Melbourne's Spencer Street Station development—renamed as Southern Cross Station—is to date one of the largest PPP projects undertaken in Australia. An examination of this project is timely because social infrastructure projects are beginning to constitute a significant amount of the transaction flow in the Australian PPP market. These projects may include courts, hospitals, prisons and even schools and perhaps even social housing. In July 2002 the Civic Nexus Consortium was awarded the contract for the station. The consortium, owned by ABN AMRO Australia, includes Leighton Contractors, Honeywell and Delaware North Australia a retail and hospitality group. The deal for the station's procurement is governed by a PPP whereby Civic Nexus will operate the station for 30 years after which the station will revert back to public ownership. In global construction markets Public Private Partnerships (PPP) have become a popular procurement model for the delivery of large-scale infrastructure projects, such as Southern Cross station. However, general criticisms of PPP's have included cost overruns, delays, issues of design flaws, write-downs, legal disputes and minimal service delivery over the long term. Despite their use by governments as a means to deliver projects, only a small amount of empirical research, alongside some theoretical debate, has examined the efficiency of PPP's as a means to deliver large-scale public infrastructure projects.

In this paper, Southern Cross Station is positioned in relation to global PPP markets as well as recent theoretical and empirical research surrounding PPP's. To do this the paper outlines the project's global financing and ownership structure. Following this, the identification, analysis, subsequent responses and monitoring of risks as they emerged during the construction process are described. The paper traces how the Station's innovative roof design impacted on construction risk and costs leading to significant financial write-downs by the contractor. The paper highlights the risk elements related to the project's design and examines these across the PPP lifecycle. This discussion reinforces the links between local PPP policies, global financial markets, iconic architectural design and on-site construction innovation. In August 2002 the Victorian government finalised its agreement with Civic Nexus consortium in order to redevelop Spencer Street Station. At the time the station was valued at $350 million dollars and it was agreed that Civic Nexus would also build $350 million worth of adjoining developments, including a shopping mall and three office-residential towers. During this time the state government will pay Civic Nexus an annual fee of $AUD 34M. It was calculated that these fees would amount to the government paying $AUD 1762M, including inflation to the Civic Nexus over the 30 year concession period. During this time Civic Nexus was to be responsible for maintaining the facility. After this period of time ownership of the station would pass back to the Victorian government.

As Peter Fitzgerald noted in his report on the Victorian government's Partnerships Victoria PPP policy 'This payment stream was equivalent to a net present cost of $AUD 309M (discounted at 8.65%, nominal pre-tax) and involved a saving against the risk adjusted cost of the Public Service Comparator at 5 per cent.' At this point in time one critic argued that Civic Nexus would make a profit of $AUD 150M for an outlay of $AUD 390M. The annual fees, to be paid quarterly are contingent on the station being maintained to a certain standard.

Alongside the financial innovation inherent in the project the other innovative aspect of the stations is its extensive roof designed to cover the railway platforms. The initial rationale for the architectural concept for the station was deceptively simple. The geometry of the 'wave-like' roof was designed in order to facilitate the extraction of the diesel fumes expelled from the interstate and regional trains without recourse to mechanical ventilation. The primary issues which impacted on the design of the stations roof was the fact that the station had to operate as the roof was being constructed above it. This limited the construction methods available and consequently the roof structure had to be designed as a prefabricated entity with structurally stable components during erection which would be clear of the tracks and associated infrastructure including overhead electrified wires.

By May 2004 Leightons indicated that the project would seriously impact on company profits. At this point in time Leightons cited the confined working environment, site access issues, the 'demands of the franchisee train operators' and 'complex design variations' as the primary causes of their problems. On the 6th of May 2002 Leightons issued a statement to the ASX indicating that these issues were resulting in time delays on the project and consequently Leightons downgraded its profit forecasts.

In PPP's such as Southern Cross Station it is clear that a project's financing template, is designed to manage generic financial risks. This template is often determined prior to the selection of a particular urban or architectural design. Built into this financial template are the project specifications which describe the parameters of function and performance outcomes required to make the project successful. Rarely do these parameters include issues surrounding the projects design except in the most ambiguous terms. In order to manage the risks on the project and to mitigate the severe site constrains facing the project the building contractors decided to co-ordinate together the architects, structural engineers and most significantly the steel detailers into a team designed to realise the roof. The involvement of the steel detailer from an early stage enable the architects vision to be realised and allowed the expert development and coordination of the roofs geometry and dimensions. As an example of a PPP project Southern Cross station appears to exhibit a two tier approach in the way risk is managed. In this approach risks are clearly allocated to parties and then partitioned off. This two tier approach means that architectural design issues are not quantified in a PPP projects generic risk framework and are often regarded as being secondary to financial considerations. An alternative would be to build into the template more nuanced notions of risk sharing and governance. In the first tier of risk management generic financial risks are managed via the projects PPP template, which is formed by the legal instruments and special purpose vehicle set up to handle the project. This generic template allows the projects financiers to raise capital from debt and then in turn equity holders for the project regardless of the projects specific architectural or urban design. The biggest risk for the financier is obviously being unable to raise the necessary capital for the project or to being unable to onsell the project to investors.

In the second tier of risk management the generic template ensures that specific projects risks are allocated to various parties within the project. In this case these risks were passed to the contractor whose shareholders bore the brunt of losses incurred as a result of site access issues. AT Southern Cross various risks manifested themselves in the PPP lifecycle at an early stage, were then allocated to the winning consortium, passed onto the contractor and then mitigated in the design development, documentation and construction stages of the project. These risks were primarily mitigated via the alliance between, the architects, structural engineer, and steel fabricator. An important aspect of this alliance was the use of modelling and design software to integrate and manage complex construction processes.

Of concern in regards to this two tier approach, as Fitzgerald notes, are issues of transparency in relation to the subsequent ownership of public assets under the PPP model. Whilst the debt and equity mechanisms of financing the station were innovative the financial complexity of these transactions are not sufficiently transparent to show the stations current ownership structure. Moreover, this approach means that architectural or urban design issues are not quantified in a PPP project's generic risk framework and these are often regarded as being secondary to financial considerations.

References

1. Timothy Dixon, Gaye Pottinger and Alan Jordan, *'Lessons from the private finance initiative in the UK Benefits, problems and critical success factors', JPIF*, 23/5 p.412

2. Peter Fitzgerald, *Review of Partnerships Victoria Provided Infrastructure, Final Report to the Treasurer*, January 2004. (Growth Solutions Group).

3. Kenneth Davidson, *'The Premier is taking taxpayers for a ride'*, *The Age,* 4 July 2002

Applying sustainable guidelines to increase competitive advantage

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Sustainable guidelines for design and construction of new buildings have been around for many years now and they have demonstrated value to owners. However, for developers, builders and others in the construction and property management fields, these sustainable guidelines have not been quickly adopted. This paper will demonstrate the many benefits to be gained by construction, development and property management organizations through the use of sustainable guidelines. These benefits can translate to direct impacts to an organization's ability to compete in the marketplace.

Keywords: Sustainable design, green buildings, return on equity, property valuation

1. Introduction

A number of recent studies have been undertaken on the use of sustainable practices, most significantly the recent Royal Institute of Chartered Surveyors (RICS) survey on GreenValue. The report from the survey found that more and more developers, investors, financiers, as well as tenants are becoming knowledgeable about sustainable benefits. The marketplace is beginning to shift toward sustainable options over older, traditional methods.

In the United States, the U.S. Green Building Council is a "voluntary organization representing the entire industry on environmental building matters. The unique perspective and collective power provides members with enormous opportunity to effect change in the way buildings are designed, built and maintained."[1] The ability to use guidelines to develop, construct and operate buildings and then translate the multiple benefits into meaningful metrics will enable organizations to bring competitive value. However, without these metrics, the benefits of sustainability can become meaningless, especially to those who must approve financing and pro-forma budgets. The explanation of value and other financial metrics will be explained in portions of this paper.

2. Sustainable guideline development

The history of sustainable guidelines varies throughout the world. But a common theme has been the rapid development and deployment of guidelines for more sustainable design, construction and operations since the start of the 21st Century. While many guidelines exist, there are several major guides that are beginning to be utilized worldwide.

In 1993 the U.S. Green Building Council (USGBC) organized to develop and disseminate sustainability guidelines for the built environment industry in the United States. Expansion of LEED certification outside of the U.S. has increased over the last two years and currently there are more than 40 LEED certified buildings outside the U.S. with many more in the application process.

In the United Kingdom the Building Research Establishment's Environmental Assessment Model (BREEAM) was developed in the mid 1990's "to assess the environmental performance of both new and existing buildings. It is regarded by the UK's construction and property sectors as the measure of best practice in environmental design and management."[2] With seven categories of buildings, one being a generic category to include all miscellaneous types, the BREEAM guidelines are structured to cover any type of new or existing facility.

Another voluntary North American initiative from the Green Building Initiative (GBI) organization is the Green Globes system. Originally brought to Canada from the BREEAM model in 1996, Green Globes was published by the Canadian Standards Association, and in 2002 was expanded to the U.K, and in 2004 to the U.S. "In 2005, GBI became the first green building organization to be accredited as a standards developer by the American National Standards Institute (ANSI), and began the process of establishing Green Globes as an official ANSI standard."[3]

Numerous other sustainable guidelines exist in various countries. The CIB set up working group 100 – Environmental Assessment of Buildings, along with the International Initiative for a Sustainable Built Environment (iiSBE) Commission, a private research group interested in sustainable building collaboration.

3. Benefits – direct and indirect

The first adopters of sustainable guidelines were the owner-occupiers of buildings. They could demonstrate immediate benefits from energy savings, water cost savings, other material cost savings and the most important, increases in workforce productivity. While the energy, water and material cost savings could be significant, the productivity increases were most dramatic. Because workers salaries make up approximately 80 percent of organizations' expenses, any improvement to productivity will multiply into huge savings and revenue increases for the organization. Developing countries stand to gain substantially, as their increases in productivity can improve dramatically with new focus on sustainable guidelines.

Other stakeholders in the building industry have not been as quick to accept sustainable guidelines. Developers, investors and financiers have been slower to see the long term impacts and benefits. But private developers of commercial facilities can find potential advantages in sustainable guidelines. Advantages include cost neutral or reduced development costs; rapid absorption; reduced vacancy; higher rents resulting in improved net operating income; and a higher appraised value of the building.[4]

The most effective methods to reduce the cost of including sustainable guidelines in a building project are to develop early design intent goals and use integrated technologies that allow maximization of performance as well as planning that incorporates engineering to reduce capital as well as operating costs.

Constructors also may benefit from similar advantages if their focus shifts to a more sustainable view. Reduced materials costs are often available if sourcing is focused on local providers. This saves transportation costs and reduces negative impacts to the environment, while often assuring faster delivery times.

Financiers and lenders are beginning to appreciate the green building support for reduced vacancies, longer lease terms and overall higher net operating incomes for the properties they fund. The risks are reduced for these stakeholders and sustainable buildings have a positive impact on all these factors.

As organizations are becoming more responsible not only to owners and stockholders, but to their communities and the world, they are beginning to take the longer view. Organizations now seek more transparency and openness and in doing so they are embracing sustainable guidelines in their facilities.

For the developer, builder, financier, owner and occupier, value has a specific and varied meaning. Each entity has it own investment, risks, and potential rewards.

The owner or investor has a substantially longer range view of returns. Sustainably built facilities can lower operating costs, increase tenant retention and return higher revenues. This increases the value for the owner/investor. Capital costs can be amortized over a longer period than a developer who sells the building after completion, hence, providing the time to reap benefits into the future.

The most appropriate way to justify inclusion of sustainable guidelines is through the use of life cycle costing (LCC). Rather than focusing solely on the initial costs of a building, LCC looks at the initial costs including design and construction and then adds the operations, maintenance, repairs, replacements and disposal costs over the entire life of the building to come up with LCC.

4. Conclusions

The long term impacts of sustainable guidelines are just beginning to be fully understood. For building industry stakeholders other than the user of space, these green benefits are beginning to be understood in financial terms that are acceptable and welcome, rather than previous perceptions of green buildings simply being more expensive to design and construct. When new financial metrics are provided for increased comfort, satisfaction and productivity, these green buildings become very profitable ventures that any stakeholder would agree brings benefits and profits.

References

1 U.S. Green Building Council, (2006, April 2), *Mission Statement,* Retrieved April 4, 2006 from http://www.usgbc.org/DisplayPage.aspx?CategoryID=1

2 Building Research Establishment's Environmental Assessment Model web site, Retrieved April 4, 2006 from http://www.breeam.org/index.html.

3 Green Building Initiative's Green Globes system web site. Retrieved April 14, 2006 from http://www.thegbi.com/greenglobes/history.asp.

4 Scott, A. and Wood, B., (2005) Green Building Can Make Financial Sense, *Land Development Today,* May, 8-11

Technology strategies for construction firms

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Current approaches to technology adoption in construction are mainly 'reactive' and lack long-term vision or strategy. Such 'reactive' approaches can have negative implications; if they are not backed by a long-term vision that takes into account emerging and future business needs to ensure sustained competitiveness. There is therefore a need to develop and implement effective technology strategies that address the current, emerging and future needs of businesses to ensure a productive and beneficial implementation of the technologies. This constitutes the primary focus of the research. This research does not advocate technology as the only means of improving business; instead it proposes to highlight the importance of well-defined technology strategies that consider aspects (besides technology) such as processes, people and management for sustained competitiveness.

Keywords: strategies, construction competitiveness, technology implementation

1. Introduction

Strong Information Technology (IT) capabilities have been a competitive necessity in nearly every industry sector. The post- Egan [1] and Latham [2] era saw many construction firms investing in IT tools in order to improve business performance. This led to an increase in IT investments in construction firms in recent years. However, many firms fail to recognise that simply investing in IT does not guarantee successful implementation. Adoption of any technology for achieving business targets requires major changes in an organisation, its current practices, systems, processes and culture (people). They need to be coupled with correct management practices and strategies. Recent studies have shown that “good management is good business” and firms are more likely to yield business benefits by marrying good management practices with IT investments [3], than by simply increasing their IT spending.

2. Technology adoption within UK construction

Previous research studies have indicated that in the UK industry, approaches to technology adoption have been mainly 'reactive', lacking a long-term vision or strategy [4]. Such 'reactive' approaches can have negative implications; if they are not backed by a long-term vision that takes into account emerging and future business needs to ensure sustained competitiveness. There is therefore a need to develop and implement effective technology strategies that address the current, emerging and future needs of businesses to ensure a productive and beneficial implementation of the technologies. This constitutes the primary focus of this research.

3. Some issues with technology adoption

According to Brown and Hagel [5] IT is a sore subject for company managements to investigate the strategy advantages of different technologies and technology architectures as sometimes the inflexible nature of IT constructs are the biggest road-blocks companies’ face when making strategic moves. This is especially true within the construction sector. Company strategies today are based on the ideas of radical incrementalism that emphasis the rapid waves of near-term operational and organisational initiatives bought into focus by a shared view of a company’s’ much longer-term strategic direction. Such incremental changes are cumulative and radical and help companies stay competitive as they are difficult to replicate. Such radical incrementalism is difficult to achieve in practice as organisational and operational inertia hinders companies from making near-term innovation in business practices and processes. Hence, if technology is embedded within the organisational structure it further hinders the organisational ability to adapt and change.

4. Using IT for better strategy

The implementation of any new technology for achieving business targets requires major changes in an organisation, its current practices, systems, human resources, processes and workflows [6]. Taking this into account, construction companies that are currently using and those who have yet to use IT tools need to take measures to successfully adopt and use technologies. The right strategies and implementation plans need to be developed, communicated, implemented and monitored. This is not easy, thus issues such as 'buy in', defining a strategy, selecting a system, developing a training programme, defining operating procedures, modifying organisational structures, and reviewing and extending use need to be thoroughly researched [6]. While there has been sufficient research in the areas of assessing the 'readiness' of organisations to adopt IT tools [7-15] there is very little evidence to suggest that construction companies develop long-term technology strategies to address their emerging business needs.

This research will focus on how construction organisations can benefit from technology by formulating and implementing technology strategies. This can be achieved through three key elements, including an organisation's strategy-development structure, evaluation process and the potential technologies themselves. This research aims to engage industry in the formulation and implementation of integrated technology strategies for sustained innovation-based competitiveness. The research will consider questions that fall into three interactive domains of vision, reality and reflection where,

- Vision will focus on the future aspirations of the organisation for competitiveness (in terms of market positioning, differentiation, core competencies and capabilities);
- Reality will focus on what already exists (processes, people, and technologies), and
- Reflection which aims to bridge the gap between reality and the vision!

References

[1] Egan, J. Sir, (1998). [Online], Rethinking Construction, Available from: - http://www.construction.detr.gov.uk/cis/rethink/index.htm.

[2] Latham, M. Sir, (1994), "Constructing the Team", Final report of the government/industry review of procurement and contractual arrangements in the UK construction industry, HMSO, London.

[3] Appel, A. M., Dhadwal, A., Dorgan, S. J., and Dowdy, J., (2004). 'When IT Creates Value. McKinsey on IT', winter 2004.

[4] Ruikar, K., (2004). 'Business Process Implications of E-commerce Applications in Construction Organisations', EngD Thesis. Loughborough University, UK. September 2004.

[5] Brown, J., and Hagel, J., (2003) " Flexible IT Better Strategy", The McKinsey Quarterly, McKinsey Publications, Vol. 4 2003, pp 60-70

[6] Ruikar, D., (2005). 'Design process improvement using a model based approach'. Ph. D Thesis, The University of Nottingham, UK

[7] ITCBP Intelligence. (2003). 'Paperless office or still sifting documents?' Weekly E-mail Briefing from ITCBP (IT Construction Best Practice).

[8] Peters, T., (2001). 'Comparison of Readiness Assessment Models', Available from: - http://www.bridges.org/ereadiness/report.html (Accessed 9th April 2004).

[9] The Mosaic Group, (1998). 'The Global Diffusion of Internet Project'. Mosaic Group, Available from: - http://mosaic.unomaha.edu/gdi.html.

[10] CERC, (1998). 'Final Report on Readiness Assessment for Concurrent Engineering (RACE)' for DICE, Technical Report, Prepared for the Advanced Research Projects Agency (ARPA) by CERC (Concurrent Engineering Research Center), West Virginia University, USA Available from: - http://www.cerc.wvu.edu/cercdocs/techReports/1993/cerc-tr-rn-93-75/race_body.pdf.

[11] Information Technology and Broadcasting Bureau, (2000). 'APEC E-commerce Readiness Assessment Guide - A Self-assessment on Hong Kong's Readiness for E-commerce', Available from: http://www.info.gov.hk/digital21/eng/ecommerce/ec_assessment.html

[12] Khalfan, M. M. A., (2001). PhD Thesis. Loughborough University, UK 'Benchmarking and Readiness Assessment for Concurrent Engineering in Construction (BEACON)', September 2001.

[13] Bui, T. X., Sebastian, I. M., Jones, W., and Naklada, S., (2002). [Online]. 'E-Commerce Readiness in East Asian APEC Economies – A Precursor to Determine HRD Requirements and Capacity Building', Available from: - http://www.apecsec.org.sg

[14] Cisco Systems, (2004). Internet Business Solutions - IQ Expertise, IQ Net Readiness Scorecard, Available from: http://www.cisco.com/warp/public/779/ibs/netreadiness/20question.html

[15] K3 Business Technology Group, (2004). 'Assessment tool checks readiness for Lean', Available from: - http://www.manufacturingtalk.com

The public sector comparator: uses and abuses

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Governments on a world-wide basis are exploring alternative modes of procurement for major infrastructure projects. One category of procurement models that has gained prominence is that of Public-Private Partnerships (P3). In deciding upon the most suitable procurement mode for a capital project, government seeks an answer to the question: which procurement mode offers the best value for money (VFM)? To help answer this question, the notion of a risk adjusted public sector comparator (PSC) has been utilized. While in theory appropriate uses of the PSC are clear, the authors have observed in practice a lack of clarity as to the uses to which a PSC can be put, and in terms of the agendas of both advocates and opponents of P3s, a number of abuses. This paper explores both, with emphasis on two different philosophies on how best to use the PSC in the search for best VFM.

Keywords: public sector comparator, public-private partnerships, decision making

1. Introduction

Governments at all levels are highly motivated to explore alternate procurement methods for public infrastructure. As a result, the concept of public-private partnerships (P3) has gained prominence. Given a project context, government needs a methodology to assist it in assessing how best to procure the project using a procurement tool kit that ranges from traditional, government led project delivery through to complete private sector delivery, with government being limited to a regulatory oversight role. The notion of a risk-adjusted public sector comparator (PSC) has been touted as the means for helping government make procurement decisions and assessing value for money (VFM). In theory, quantitative evidence to support judgment that VFM has been achieved is provided through the use of a comparator [1], [2].

We examine two different philosophies associated with a PSC as part of the procurement mode decision making process, the pros and cons of each, issues associated with making adjustments to the PSC during the procurement process, and finally, the validity, if any in a post mortem analysis, of comparing hypothetical numbers associated with the PSC with the actual outcome.

2. Background project scenario

Use is made of a simplified yet realistic scenario which provides a useful backdrop to the discussion. Our perspective is that of government doing the data collection and analysis as of *time now* (i.e. all estimates are projections of future events) for purposes of making decisions as to the best procurement mode and allocation of risks. The type of project selected involves a revenue function that has both a user pay component, as well as a direct subsidy from government.

3. Uses / abuses of the PSC

A graphical representation of the procurement mode decision making process is provided, along with the growth in information from both the public and private sector perspectives. Attention is directed at an important juncture in the decision process as to the role of the PSC in selecting the preferred procurement mode. Two different approaches for choosing this mode are discussed, along with the pros and cons of each.

The first alternative involves 3-parts for selecting the preferred procurement mode. It compares the PSC using 'traditional' procurement to the cost / revenue to government using P3 procurement – i.e. the PSC plays a central role in deciding upon the preferred procurement option. We note that Partnerships Victoria [3] is not in favour of this approach, while it forms the backbone of the approach used in the Provinces of British Columbia, Alberta and Ontario, Canada. The three parts are:

(i) The first part involves establishing the benchmark to beat, called PSC_T herein. This involves pricing out a government led project delivery using information developed to date. It is assumed that efforts are made to optimize the choice of traditional delivery mode, all potential costs are included, and operation and maintenance costs are priced to reflect the same quality of service demanded of P3 delivery. Ideally, output from this part of the analysis is a cumulative distribution function (CDF) for PSC_T.

(ii) The second part of the approach involves preparing a shadow bid that reflects the viewpoint of a concessionaire competing for the project under a P3 procurement mode, with an assumed level of risk transfer / risk sharing. Challenges for government in preparing a shadow bid derive from the need to assess the synergies that might be achieved from bundling all services required into one concession agreement, the need to assess and price innovation potential, and the need to adopt a private sector perspective as to the project's risk profile, how best to manage it, and aversion to risk. Based on the risks assigned to the private sector and its attitude toward risk, the shadow bid is used to provide an estimate of price certain of the payment stream required from or to government.

(iii) The third part of the first approach involves taking price certain from (ii) and combining it with all remaining expenditures and risks retained by government. The net present worth of the corresponding cash flow, PSC_{P3} is then computed, and compared with the value PSC_T computed in the first part. Then answers can be sought to questions such as: What is the probability that PSC_T is less than PSC_{P3}? Then depending on the government's risk tolerance level, a choice can be made between 'traditional' and P3 procurement.

Several pros and cons accompany the 3-part outlined above. Selected advantages include:

- Use of a PSC forces government to examine critically its traditional procurement options and optimize them to the extent possible;
- The need to formulate a PSC forces government to examine the true cost of 'traditional' procurement;
- Proper formulation of a PSC requires the formal treatment of risk;
- Use of a PSC forces greater accountability and transparency in decision making; and,
- Formulation of a shadow bid allows relatively easy termination of the process if it becomes clear that the difference in VFM offered by the two approaches is minimal or a distinct advantage exists for traditional delivery.

Disadvantages of the approach, some of which can lead to abuses include:

- A bias toward one procurement mode being preferred to the other can lead to manipulation of the PSC and / or the shadow bid;
- It is difficult for the public sector to adopt or possess a private sector mindset in formulating a shadow bid; and,
- For both approaches is an abuse by opponents to P3, who try and use the PSC and results of the shadow bid to discredit the use of P3 based on the results of negotiations post the RFP step, by comparing estimates of a future outcome frozen at a point in time with the actual outcome which is based on much more information.

For the second approach, only part (i) of the first applies, with the decision about VFM and other metrics being made independent of the formulation of a PSC, and seemingly in some cases on philosophical or ideological grounds. There is some sharing of advantages with the first approach, but with the loss of some of the advantages cited for the shadow bid process. However, an advantage of the second approach is that it avoids the need to quantify efficiency and innovation potential and the pricing of risks on the part of the private sector, thereby sidestepping two thorny issues and providing potentially less ammunition to opponents of P3. However, having decided to proceed down the path of P3, the enormous amount of momentum that is developed makes it difficult to abort the process if P3 does not demonstrate VFM when bids are received, with the government's concomitant loss of face and credibility in the eyes of the private sector.

4. Conclusions

In this paper, the authors have explored two approaches to the use of a public sector comparator (PSC) in making a decision about preferred procurement mode, and pros and cons with each. The first approach involves developing a benchmark, the PSC, and then comparing it with the results of a shadow bid prepared to reflect the viewpoint of the private sector, assuming P3 procurement. The approach offers several advantages, with the main one being that the P3 choice can be eliminated early on if it does not show VFM compared to traditional procurement. Selection of the preferred procurement mode without use of a shadow bid has the advantage of not having to make a large number of assumptions as to how the private sector is likely to price a P3 proposal. But it comes with a significant risk that the private sector will have expended significant resources on a project best suited to traditional procurement.

References

[1] HM Treasury (1998) Public Sector Comparators and Value for Money, HM Treasury, London, U.K.
[2] Ball, R., Heafey, M., and King, D. (2000) Private Finance Initiative – a good deal for the public purse or drain on future generations?, Policy & Politics, 29 (1), 95-108.
[3] Partnerships Victoria, (2003) Public Sector Comparator -Supplementary Technical Note –, Department of Treasury and Finance, Victoria, Australia

Unifying CPM and linear scheduling: a definitive treatment

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Described in this paper is a planning and scheduling approach that unifies traditional CPM, Line of Balance (LOB), Linear Scheduling Method (LSM) and Linear Planning (LP), and which also treats true hierarchical scheduling. Central to the approach is a rich set of planning structures and generalized precedence relationships that treat both the time and spatial separation of work. Features of both are illustrated, an overview of the scheduling algorithm is given, selected aspects of the computer implementation in a system called REPCON are shown and discussed, and potential enhancements identified.

Keywords: linear scheduling, CPM, unified approach

1. Introduction

Described in this paper are a planning and scheduling approach and accompanying tool that unifies, in a definitive manner, traditional CPM, Line of Balance (LOB), Linear Scheduling Method (LSM) and Linear Planning (LP). The approach is equally applicable to representing projects with no repetition of activities to ones dominated by significant repetition, allowing a single tool to meet the totality of planning and scheduling needs of a firm, negating the need for specialist tools. The topic of modeling projects which involve significant repetition of components and activities has attracted the interest of many researchers. Stradal and Cacha [1] in their seminal paper on time-space planning delineated many of the features desired of an implementation of the methodology, and noted that a general mathematical formulation capable of being implemented in a computer environment had yet to be developed. Over the ensuing years, many authors have tackled aspects of the problem [2], [3], as have the authors of this paper – e,g. [4], [5], [6], [7].

The paper is arranged around four main themes: representation / modeling of projects, algorithmic and implementation issues, schedule visualization and user interface issues, and value-added features.

2. Representation & modeling issues

The realistic modeling of a project's plan and schedule deals with how to articulate observations of actual construction practices and findings from the literature in a flexible and general manner that can be captured in representation structures which have rich expressive powers. Our view is that a general approach must reflect the union of all features of traditional CPM plus the strengths offered by LOB, LSM, LP minus any unnecessary assumptions, be mathematically based, and to the extent possible, adhere to the terminology of CPM. This means the ability to support a full set of logic relationships including spatial offsets or space buffers with positive and negative time lag and spatial buffer values, accommodation of date and float constraints, treatment of intermediate logic relationships and cyclic work relationships, treatment of multiple calendars both for activities and logic relationships and variable time units, work continuity where appropriate, work interruptions in repetitive work, the ability to crew up and crew down, variable production rates and work scope at different locations, different work location sequences for different activities, no requirement that all activities be present at all work locations, and flexible resource usage modeling. The concept of work locations should be thought of in general terms, embracing off-site processes as well as on-site physical locations. In addition, to handle large scale projects, the use of true hierarchical scheduling should be incorporated. All of the foregoing issues have been addressed in the approach described. A basic concept behind the suite of planning structures developed to date is that a single activity or planning structure can appear at multiple locations, rather than having to define a separate activity for each location instance. A family of planning structures has been created, with activity members being named ordered, continuous, shadow, hammock, start and finish milestones and derived. Accompanying these planning structures, generalized precedence (logic) relationships have been defined. Rather than manipulating individual activities, as is done in traditional network analysis, the user first defines a planning structure that describes the locations worked and the sequence in which they are to be worked, requirements for work continuity, production rates, and crewing strategy, and then connects this structure to others using the generalized precedence relationships. These capabilities have been incorporated into a true hierarchical scheduling paradigm.

3. Algorithmic & implementation issues

A challenge successfully addressed was generation of an internal network representation of the project and determination of activity structure sequence step numbers which reflect all properties of the planning structures, their hierarchical and logic relationships, and other constraints such as work continuity, date and float constraints, activity interrupt requirements, and the use of multiple calendars. An overview of the scheduling algorithm developed and implemented in a system called REPCON is presented in figure 1.

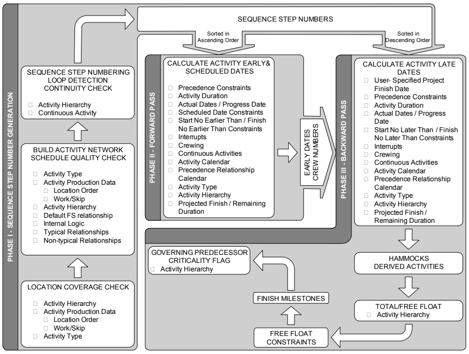

Figure 1. Overview of scheduling algorithm

4. Schedule visualization and user interface issues

Visualization of the project plan and schedule is key to developing insights on the workability of the construction strategy being pursued, the quality of the plan specified, and on determining the most sensible corrective action strategies once work is underway. Bar chart, network diagram and time-space or linear planning graphics are supported, with an example of the latter shown in figure 2.Regarding user interface issues, extensive support is provided in terms of the ability to formulate finely tuned select/sort activity profiles, scroll both the time and space dimensions, zoom in both the time and space dimensions, use different colours to differentiate amongst project participants, and tile the same or different schedule representations at identical or different granularities.

5. Value-added features

2 and 3-D resource representations can be generated, with the latter being very useful to determine the distribution of resources in time and space, thus helping with the assignment of supervisory personnel to ensure effective spans of control. It is also possible to examine the potential for congestion and develop productivity profiles

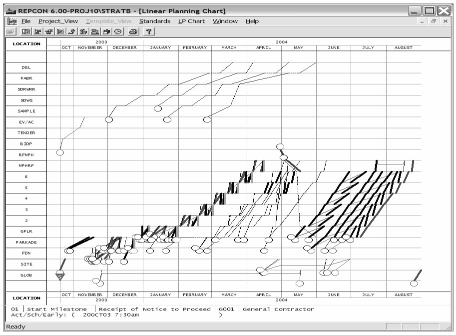

Figure 2. Linear planning chart

6. Conclusions and future work

Features of a unified, mathematical formulation of CPM plus the strengths offered by LOB, LSM, LP minus any unnecessary assumptions, within a hierarchical framework, have been described. Future work seeks greater computational efficiency and more flexibility in the time-space graphics.

References

[1] Stradal, O. and Cacha, J. (1982) Time space scheduling method. *J. of Constr. Division*, ASCE, 108(3), 445-457.

[2] Lutz, J. and Hijazi, A. (1993) Planning repetitive construction; current practice. *Constr. Mgmt. and Economics*, 11, 99-110.

[3] Harris, R. and Ioannou, P. (1998) Scheduling projects with repeating activities. *J. of Constr. Engrg. and Mgmt.*, ASCE, 124(34) 269-278.

[4] Russell, A. D. and Caselton, W. F. (1988) Extensions to linear scheduling optimization. *J. of Constr. Engrg. and Mgmt.*, ASCE 114(1), 36-52.

[5] Russell, A. D. and Wong, W. C. M. (1993) A new generation of planning structures. *J. of Constr. Engrg. and Mgmt.*, ASCE, 119(2), 196-214.

[6] Russell, A. D. and Udaipurwala, A. (2001) Integrated project planning through hierarchical scheduling. *Proc. ASCE Specialty Conference on Fully Integrated and Automated Project Processes (FIAPP) in Civil Engrg.*, Sept. 26-28, 2001, Blacksburg, VA. 311-321.

[7] Russell, A. D., Udaipurwala, A., and Wong, W. (2003) A generalized paradigm for planning and scheduling. *CD Rom Proc., Construction Research Congress,* 19-21 March 2004, Honolulu

Enhancement of the briefing process by assessing building performance

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One comprehensive trend across the world is a trend towards performance-based briefing/programming, design and management of facilities. Construction professionals and facility managers are taking a more systematic approach to designing and monitoring building performance, aiming to keep down costs, reduce energy usage and making the best of building systems. However, one off the less well exploited opportunities for improving performance, reducing costs and abortive design time lie in the developments of the construction client's evaluation process. This paper reports findings from a questionnaire study of the evaluation of the building performance. Aspects that help clients to formulate evaluation procedures are discussed. It is concluded that there is a significant value in the assessing of building performance also for development of the clients' briefing process.

Keywords: evaluation, briefing/programming, construction client, questionnaire

1. Clients' evaluations

The outcome of documenting and assessing activities, projects and processes is often pointed out, but why is it so important and how is it done? Without an evaluation or follow up of what has been done it is impossible to comment on potential effects or even know anything about what was carried out. Sharing experiences with others is also important. At the same time it should be pointed out that evaluations as such are part of an ongoing learning and growth process. Naturally the results of the evaluation must also lead somewhere. This executive summary compiles findings from a questionnaire study of the evaluation of the building performance with the purpose of finding aspects that help clients' to formulate evaluation procedures.

1.1 Purpose and background

The R&D project as a whole will analyse why clients' rarely evaluate whether the end products of the building process meet the business requirements. The over all purpose is to highlight and tie together the need to formulate relevant requirements during the early phase with feedback from later phases of the building process. The intention is to develop a method for assessing construction and management projects, as a tool for the client to use when following up on the require
ment and goal definition process. Feedback from completed projects increases the construction client organisation's ability to formulate relevant and verifiable operations-related functional requirements in upcoming projects.

Evaluations help us to learn about and improve upon the characteristics of premises. Evaluations can also serve as a means for reassessment and to report on accountability. Facilities that are appropriate for their purpose are an important production resource within organisations. Facilities are also more than just that. They often represent a significant portion of assets in the balance sheet. Unfortunately, risks are associated with fixed assets, depending on the condition and location of the premises, the length of the lease, and other factors. Uncertainty about the type of premises needed in the future also involves taking risks.

Other reasons for evaluating premises include:

- Obtaining a basis for decisions about whether a completed facility refurbishment should continue to be used in its current form, be improved, sold, or demolished. (summative evaluation)
- Helping and supporting the operation's current use of the facilities (formative evaluation)
- Predicting the success of a facilities planning project (prognostic evaluation)
- Assessing whether premises have been modified according to plan (evaluation of implementation).
- Cost cutting measures / refinement of value (customer benefit, efficiency and returns, value growth)
- Providing incentive for more effective utilisation of premises

2. Evaluation, assessment and follow up – What's the difference?

One difference between construction projects and political interventions or public administration – areas in which evaluation theory is well developed [1] – is that construction projects are divided into distinct phases that all have completely different results. In the initial planning phase we decide on the facilities' properties, resulting in a brief and a model, mainly in the form of descriptions and drawings. The second phase, construction, results in the material artefact. Thereafter the use phase begins, in which the results are used and managed. All three phases can be evaluated individually or taken together. For example, in architectural contests the results are evaluated during the planning phase. Surprisingly, the built environment in the later phase is seldom evaluated.

According to Vedung [1] concepts like evaluation, assessment and follow up interchangeably are often used. However, there are differences. Evaluation and assessment can be used synonymously. An evaluation means some form of review and analysis of whether a project or activity has succeeded in achieving its established goals. The review is based on systematically gathered information anchored in defined purposes and issues and with relevant methodology. Evaluations answer questions such as: has the change in the facilities had any effect, what has worked and what has not worked, what can be improved? A follow-up is somewhat less obligatory. In a few words, it entails describing what has been done and is based on regular and continuous gathering of information that makes it possible to see long-term changes. A follow-up does not contain the same requirements for analysis and quality assessment as an evaluation of how facilities are used.

Evaluation means: systematic retrospective appraisal of processes, accomplishments and outcomes. Systematic means that data collection for an assessment must be done systematically. Retrospective means that it is something you do ex post, afterwards. But an assessment can also be done ex ante, such as prior to a programme for refurbishing premises or a preliminary study.

As early as the beginning of the 1960s, procedures were developed in the US to systematically evaluate buildings – Environmental Design Eval uation or Building Diagnostics. The adopted term is Post Occupancy Evaluation (POE); which assumes that the user’s assessment will constitute part of the evaluation and that the evaluation is carried out after the building has been taken into use. Post Occupancy Evaluation is used today as an international collective term for all types of evaluation methods aimed at providing feedback – from buildings and premises that are finished, delivered and taken into use – based on the perspective of the operation [2]. Other equivalent international concepts are *Building Performance Evaluation*, *Post Project Performance* or *Customer Satisfaction*.

3. Results from the questionnaire

The questionnaires were distributed to 96 selected prospective participants. Participation was anonymous and voluntary (response rate 58%). General observations from the questionnaire study include:

- Evaluation is most necessary in two categories: Safety and User Satisfaction.
- A Customer Satisfaction Index is seldom used, even though customer satisfaction is important.
- The construction project manager and client organisation should carry out the evaluation.
- Lack of time and planning are key factors for not carrying out evaluations.

4. Conclusions

This research project will encouraging the improved use of feedback particularly for clients with continuous building programmes that will facilitate the prescription of tried and tested solutions yet allow and encourage value-adding innovation in a controlled manner. Thus, following seven fundamental questions can be asked prior to each evaluation of the operation's and end-users use of premises:

1. Purpose – (Why evaluate and how should the evaluation be used?)
2. Object – (What should be evaluated? How do you make suitable limitations?)
3. Organisation – (Where and who should be evaluated? Based on whose perspective should the evaluation be carried out? Who ordered/purchased the evaluation?)
4. Criteria – (What criteria should be used and how is their value assigned?)
5. Methods – (Which evaluation methods should be used?)
6. Distribution – (How and to whom should the results be distributed?)
7. Use – (What effects can be expected? How will people handle the results?)The purpose of the evaluation is to understand which strengths and problems the use of the facilities generates in the users' daily activities. Hence, applying systematic feedback to improve the briefing process. The improvement of the client briefing and evaluation process by systematising the gathering and application of feedback from completed projects to improve the construction industry productivity, building performance and user satisfaction.

References

[1] Vedung, E. (1998) Utvärdering i politik och förvaltning, Studentlitteratur, Lund.

[2] Preiser, W (1989), Building Evaluation, Plenum Pr., New York.

Construction client's requirements – Innovation in construction project management

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This paper report from a study aimed to develop and suggest methods that will enable innovative and effective collaboration between clients and construction project management. It builds on research within the field of briefing, construction project management and is based on interviews and workshops. The purpose of the workshops was to exchange expertise between different client organisations. Increased need for professional clients and the aim of construction project management professionals to engage in a wider range of tasks and activities is the main outset. The focus is on project management and how it succeeds to convert the construction client's corporate strategy and business into property investment or corporate real estate decisions. Such knowledge should make it possible to create innovative methods for facilitating construction briefing and project management. It will also support the provision of facilities and provide understanding of the consequences of strategies or methods for the improvement of the performance of the client organisation's business objectives in construction projects. The development of such knowledge is of particular interest for client representatives, project managers, development managers, facilities managers and design managers in the construction sector.

Keywords: briefing, usability, process, professional logics, stakeholders.

1. Roles and processes

The client's goal of raising quality and implement end-user focus and at the same time outsource the management process of the finalizing of facilities, denominates a fundamental gap between two different logics, the one of the client and the one of the construction management professional. This is illustrated by the fact that there is a discussion on the need for facilitators in interpreting the requirements of the client, rather than a discussion on the role of construction project managers. This questions the role of construction project managers and the relationship to and integration of clients' objectives. When there is an increased need for professional clients and the aim of construction project management professionals is to engage in a wider range of tasks and activities, there is a need for an innovative approach that develop roles and relationships that satisfy the clients objectives in construction projects [1, 2, 3].One trend is an increased customer focus, and focus on core activities. Today the client is being given more formal responsibility for the management of building projects due to regulation. The pace of change within the organisations has also increased, with more frequent moving and shorter planning horizons for both production and facilities [3].

2. Stakeholders

Construction clients have a key role as the initiators of projects and often also represent different interests in terms of required services, functions, designs and interpretation aspects. As a rule, construction clients also finance the projects and are responsible for ensuring that needs and preferences of the end user are met. In much of the recent debate on the construction industry, clients are pointed out as the major steering force the construction processes.

Today construction project managers act on behalf of the client in the design and/or production phase of a construction project. The client focuses on core activities and has outsourced the responsibility of the process of providing facilities to the construction manager. The client might even have changed the organization to such an extent that there is very limited competence concerning construction in the client organization. The construction project manager then carries the responsibility to deliver what has been defined in an agreement/contract.According to results from research there is an increasing interest among construction clients towards a more value based and operational-oriented management process. It is reasonable to believe that this has led to a need for experts who understand the differences between strategic/external and operative/internal management processes without focusing too much on building-related solutions. This implies a possibility for project management professionals in construction to develop and provide expanded services to clients. Alternatively, new actors among other professionals in the construction sector may appear. The need for specialists (facilitators) to bridge the gap between corporate strategy and the development of building projects have been identified [4].

3. Client/User requirements

The workshops indicated an urge for revaluing the briefing process in order to meet client/user requirements. During the last decades, however, the need for better briefing with the focus on end-users is increasingly recognised in professionalizing the demand in building and construction among clients, industry and researchers all over the world. Emphasis is put on a desire to manage the brief with a more strategic focus on end-results, facilitating the user's business process rather than focusing on the technology of building parts and components.

The workshops also pointed to difficulties for construction projects to deliver what the user-clients need. It was found that user demands were hard to define and measure on the construction project level and thus difficult to validate during the construction (production) process. The functions defined in the brief were described as cumbersome to communicate and translate to production activities. The workshop participants considered there to be a lack of systems or methods to sufficiently and satisfactory keep track of user client demands. Furthermore, a trend of increased interest for process-oriented briefing was indicated as well as the need for more research for about collaborative working. Also communication and interaction capabilities are considered vital.

4. Discussion

Reflecting on current research and developments we can see that there are two different logics governing the users and the construction companies. This difference we conclude is not addressed to a large extent, if at all. The differences lay in the views of several aspects of projects and user activities. First and foremost is the difference of project scope. For the user the scope is continuous and permanent, for the construction company it is project by project. So, who should govern the construction process?

The client needs to be skilled in choosing the right experts or consultants for both demanding what shall be supplied, the briefing, and how it should be achieved, the construction. If the client isn't as professional as required the logics of the consultants prevail rather than the clients. It can be argued that the users can not focus on complex construction issues instead of their professional core business. That is correct, but the construction project management must improve skills in communication and interaction with core business. Construction must be delivered by the logic of user's permanent organisation rather than the project by project approach utilised by the construction sector.

5. Why innovation is needed

The developments and discussion above challenges the traditional role of several actors. The clients need to be more knowledgeable either by developing their own organisations or by using appropriate support, such as project managers, facilitators or similar professional roles. There is a need of choosing logic – this does however not diminish the need for methodologies for capturing, processing and verifying requirements in the process of provision of facilities to a user. Thus, elaborating the client perspective empowers a demand driven attitude that will lead to an integrated approach and stimulate a reformed management of construction projects. This is a field that will require studies and research in order to develop a client/user driven construction process that is more than just new statements.

References

[1] ECTP, European Construction Technology Platform (2006), Strategic Research Agenda.

[2] Ryd, N. (2003), Exploring Construction Briefing – From Document to Process, Chalmers University of Technology, Gothenburg.

[3] Lindahl, G. and Ryd, N. (2006), Performance, report R&D project no:11, Swedish Council for Constructing Excellence (BQR), Evaluation tool for project follow-up, Chalmers University of Technology, Gothenburg, Sweden.

[4] Ryd, N. (2004), "Facilitating Construction Briefing - From The Clients Points of View", Nordic Journal of Surveying and Real Estate Research, Vol 1:2004, pp. 86-101.

International comparative study on “Kouji-Kanri (construction supervision)” as construction conformation

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The purpose of this paper examines that the role of construction supervisor in Japan is changing to the management field and construction conformation field, based on the analysis of the WBS (Work Break Structure) by the international comparison among Korea, China, the UK, the US, and Japan. The Choice of better procurement is essential to the success of construction projects. This paper also explains that characteristics of quality control system of Asian countries and makes some suggestions to improve quality of construction projects.

Keywords: Client Procurement, Construction Management, Project Management, Inspection

1. Introduction

In addition to Design Build or Design-bid-Build, supply system of Japan is being diversified by the introduction of new procurement such as Construction Management etc. Various construction supervision -- many specialists, such as a construction supervisor from designer side and builder side as a third person, a construction manager, or a project manager, etc., has been introduced. Construction supervision business of Japan is legally defined with design documents. The main activity of construction supervisor is formal conformance check between product and design documents. On the other hand, the management function itself is not legally defined. In the US & UK construction project, management systems, such as CM system, were introduced and both quality reservation and client’s demand are already realized. The purpose of this research is to clarify the feature of the present construction supervisor. Furthermore, international comparison of the U.S., UK, China, South Korea, and Japan is performed about the relation between construction supervision and construction management.

2. International comparison of construction supervisor’s activities

This paper examines international comparative study among five countries, Japan, USA, UK, China, and Korea by activities during construction phase. There are some characteristics among other countries as follows:

a) All countries defined architect’s role for passing along design intent.

b) The activity of conformation of construction and design defined Clerk of work’s role in the UK. Under AIA contracts in the US, architect has similar role to Construction Manager as conformation activity.

c) Inspection & Advise of Execution scheme are mainly supervisor’s activity, but conformation of design and shop drawings are different country by country. China and Korea defined construction supervisor’s activity; on the other hand, UK and US defined architect’s activity.

3. Main body of construction supervisor’s activities

The real chief mourner object of the construction supervision business in each country also changes with countries.

a) USA

In the U.S., inspection by the builder and inspection by the government organization are distinguished, and it is in contrast with Japan. Quality inspection in Japan depends on designer. The quality inspection by the administration in the U.S. is defined as inspector system of state level.

b) UK

In RIBA (Royal Institute of British Architects) Conditions of Engagement (1966 version), the difference between a designer and Clerk of Works is shown as follows;

Supervision: Resident Architect

Inspection: Clerk of Works

"Clerk of Works" mainly has five business, Anticipation, Interpretation, Recording, Inspection, and Reporting. In this meaning, it can be said that “Clerk of Works” is carrying out broader quality control business with the designer.

d) KOREA

Existence of the construction supervisor, who performs construction supervision business according to the construction value and belongs to private construction sector's supervision special company, is characteristic in South Korea. Although public officials who belong to the organization perform construction supervision business as a superintendent in public works, in addition to the superintendent belonging to client organization, if the total cost of construction projects are over 10 billion won or more, the supervision member which belongs to the supervision special company of the field construction performs "responsibility supervision" business (construction technical law article 27) must be hired.

e) JAPAN

In Japan, the design office which took charge of the design takes charge also construction supervision business in many cases. However, adopting third person supervision positively in the latest public building construction etc. also has many examples which choose a construction supervisor who is not designer.

4. Survey results

- Conventional Japanese construction supervision is defined not only conformance check between product as quality control function and design documents, but also management in construction process whose definition is broadly excess the legal function of the construction supervisor set by the Japanese architectural law article 2.
- When the diversity of a project is taken into consideration from now on, the subject which carries out construction supervision is also various.
- Moreover, although only the conformance check business is prescribed about the construction supervision business defined as the present notification No. 1206, it is required to clarify the people who the conformance check with client demand and management business used as the basis of a construction project.
- For that purpose, classifying into "conformance check business" and "management business" clearly, and deciding the operating, responsibility person is very important to develop construction industry. From now on, conventional construction supervision business which defined more broadly should been transformed to new construction supervision business which redefine as quality control business during construction phase by conformance check between product and design documents, moreover, the definition of new construction supervision business should be able to make a choice of supervision activities according to the characteristics of construction projects and characteristics of client demands like UK & US experience.

References

[1] AIA (1997) AIA 201/ CMa, General conditions of the contract for construction manager adviser edition, The American Institute of Architects, US

[2] Bennett, J. (1991) International Construction Project Management, Butterworth-Heinemann Ltd., Oxford, UK

[3] Chappell D, (2000) Understanding JCT, Standard Building Contracts, Sixth Edition, E&FN SPON, London, UK

[4] Construction Manager Research Committee (2002) Kensetsu-gyo Shinkou Kikin, Tokyo, Japan, http://www.yoi-kensetsu.com/cm/index.html

[5] Cox A., Thompson I. (1998) The Contracting for Business Success, Thomas Telford, London, UK

[6] ICW (1994) Clerk of Works Manual, RIBA, UK

[7] JCT (2000) JCT 98 2000 edition, The Joint Contracts Tribunal Limited, UK

[8] Murdoch J., Hughes W. (1992) Construction Contracts, Law and Management, E&FN SPON, London, UK

[9] SAITO, T., FURUSAKA, S., MINEMASA, K. (2003) pp145-152, Construction Supervision of Public Projects, Research Paper of Japanese Architectural Institute No. 574, Tokyo, Japan

[10] SAITO T. (1994) A Comparative Study of Procurement Systems in the UK and Japan, CIB W92 Proceedings Publication 175, pp389-398, Hong Kong

[11] SAITO, T., Furusaka, S., Kaneta, T. (2005) A step forward to improve the Japanese Construction Supervisor by introducing Toyota Production System, CIB W55&65 Symposium, Helsinki

[12] Takahiro FUJIMOTO (2001) Business Architecture, pp3-26, Yubikaku, Tokyo, Japan

Construction productivity measurement: the first step for increasing the competitiveness of Italian firms

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This paper presents the initial methodological considerations for doctoral research aimed at developing measurement criteria for construction productivity in Italy. The characteristics of the local construction market and the need for measuring productivity are introduced in the first part of the paper. This type of study has never been performed in Italy. In the second part the findings of several past productivity-related studies are discussed, as a basis for developing meaningful measurement criteria. The central part of the paper addresses most of the factors that influence productivity. They are grouped into three areas: site conditions, management and personnel motivation. Measurable and non-measurable productivity factors are identified. In the last part the methodology for developing the study is outlined. Regression analysis could be used to develop a productivity function. In this regard an example is used to show the possible outcome of this approach.

Keywords: Construction management, Productivity, Measurement criteria.

Introduction

The issue of productivity in construction has been the subject of many international studies, but it has received very little attention in Italy.

This paper presents the initial considerations for a measurement study of the productivity of Italian construction sites. The paper addresses the reasons for this undertaking, summarizes some of the findings of past productivity studies and outlines a logical roadmap for further research. The completed study is expected to show improvement opportunities for the capabilities of Italian construction firms.

1. Research motivation

Labor productivity is of central importance to the economic health of the Italian economy. Due to the size of the construction industry, any productivity change has significant direct effects on the overall productivity and well-being of the nation.

The research topic of construction productivity was induced by the fact that many studies have been carried out internationally in this regard, but very little attention has been paid in Italy to date. The opportunities for productivity improvement in Italy are many, because the productive time of an average Italian construction worker is 30-40% of his 8-hour working day.

2. State of the art

In many industrial sectors, productivity is generally measured in the same way. It is given by the following ratio:

$$productivity = \frac{input\ (resources)}{output\ (units\ of\ \ products)} \qquad (1)$$

The value of the ratio varies, depending on the criteria according to which its numerator and denominators are quantified. In production terms, standard productivity usually relates output to the quantity of labour used, measured in work-hours. Sometimes the ratio relates output to capital input.

In the construction industry, it is very difficult to quantify output, generally expressed in physical units. This difficulty results from the nature of construction output. Buildings, in fact, differ from each other in terms of quality and technologies, differently from the standard products of manufacturing. A possibility is represented by considering output in terms of monetary or functional units.

New construction management theories suggest that productivity depends on the reliability of some flows at the construction site. Main flows to be considered are materials, information, equipment and labour. The efficiency of these flows offers the possibility of achieving good performance [1].

In construction, labor reaches up to 60% of the cost of a construction project, while material represents only 25-30%, so most of the opportunities for efficiency improvement should be found in the area of labor.

3. Factors influencing productivity

The central part of this study focuses on those aspects that influence productivity and shows all the factors, grouped in homogeneous categories, which can change productivity performance.
The factors are organized into three broad categories: *site conditions, management and personnel motivation*. Each category may have a significant impact on the performance of construction activities, although in a different way.
The first category, site conditions, encompasses all the aspects that depend directly on a specific job ,and it is divided into four subcategories: job complexity, climatic aspects, site space conditions, and type of project delivery system.
The second category concerns the contractor management system and consists of three sub-categories: site management, technologies and personnel supervision.
Personnel motivation, the third category, is characterized by measurable and non-measurable dimensions. Their impact, however, cannot be quantified easily, given the intangible and varying nature of the social and personal situation of construction workers.

4. Research methodology

Activity sampling is one of the best ways for obtaining detailed knowledge of the performance of any production process. This method can be used for comparing the performance of a set of construction sites. For the practicality of the study to be undertaken, only one type of construction activity should be considered. Therefore the investigation will be limited to a set of concrete structures of residential or office buildings. In Italy, this category of work represents approximately 30% of construction costs and has a significant impact on the total duration of a construction project. In addition, concrete activities can be easily analysed, measured and compared from site to site.
A cost analysis will be undertaken for every observed site to define the factors that influence productivity. A regression analysis will be used to develop a productivity function. The objective is to understand which aspects have a stronger impact on construction productivity. Measurable and non-measurable factors are to be noted. In order to clarify what influences productivity, the following equation is used:

$$P = F\,(x_1, x_{2,\dots}\, x_{i,\dots}\, x_n) \quad (2)$$

where x_i are the previously introduced sub-categories influencing productivity. We cannot say what kind of function relates productivity to sub-categories. A possible solution is to collect data from a large set of different sites and develop a statistical model. Each of the parameters of equation (2), in addition, is to be weighted and its cumulative impact considered. In practice, each x_i will have two components: a_i and b_i. The first one refers to the assigned weight, depending on a given project; while the second one considers its cumulative impact. From these considerations, equation (2) can be further developed into:

$$P = F\,(a_1b_1x_1,\, a_2b_2x_{2,\dots,}a_ib_ix_{i,\dots,}a_nb_nx_n) \quad (3)$$

This hypothetical equation should be validated with a mathematical model developed on the basis of a large number of observations. It is important to underline that, while equation (2) may be valid, equation (3) needs to be verified, because it is only a starting hypothesis based on intuition. In this regard, a test is to be developed to verify the likely results of the proposed methodology. The test should focus on the variability of at least two factors depending on site to site and eventually indicate the way how a meaningful and valid mathematical model should be developed, in order to show the relationship between a given factor and productivity outcome.

Conclusion

This paper has outlined the preliminary methodological considerations for undertaking an in-depth study of construction productivity in Italy. For practical reasons the study will be limited to concrete structures only. Future investigation efforts should focus on quantifying the impact that some of the above-listed factors (related to site conditions, management and personnel motivation) have on final productivity.

References

[1] H. Randolph Thomas, Michael J. Horman, Ubiraci Espinelli Lemes de Souza, Ivica Zavrski, “Reducing Variability to Improve Performance as a Lean Construction Principle”, *Journal of Construction Engineering and Management* Volume 128, 2 , pp. 144-155.

Waste in construction projects: a client perspective

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One of the most prioritised activities in order to improve construction should be to eliminate waste. This paper summarizes experiences from an empirical study of waste in Swedish construction projects. A number of studies have been performed to collect data: direct observations, interviews, group discussions, studies of project data and studies of other relevant data. The waste, which is found to be at least 1/3 of the total cost of projects, is of practical reasons presented in four main groups: defects and inspections, use of resources, safety and health, structures and systems. Four general obstacles are presented.

Keywords: Waste, construction, defects, non-value adding activities

1. Introduction

Most actors in construction see that there is a possibility to lower the production costs, i.e. the total cost for the project. However, there is a disagreement on which cost elements and what reasons lay behind the present production costs. Trade organisations claim that the burden of taxation on new houses should be lowered. Other groups of actors point at problems with governmental control, time aspects, complex project organisations, inefficient production, low competence, high material prices, etc. One way of getting a better overview of the cost structure and the possibilities to reduce costs is to identify waste affecting the client in building projects.

The aim of this paper is to present wastes in construction affecting any part of the production cost of a building project. Waste is seen as “all activities which absorb resources without adding value to the customer. We see the client of a building project as the customer.

2. Method

The study was carried out in two stages: first to identify sources of waste and then to quantify them. The study was guided to a certain extent by the fact that the major part of the data was collected in four housing projects.

We first made a study of the literature and held eleven group discussions with practitioners in order to identify as many examples of waste as possible. When we had described the purpose of the study, we asked each participant to write down as many examples of waste as possible. These meetings generated a total of 750 examples of waste – or at least what some individual considered to be waste.

The quantification of waste was connected as closely as possible to four building projects. These areas were divided so that we researchers made special literature searches in the areas that had already been studied while the four participating companies took the responsbility for collecting information in other areas. The way the different inventories were carried out depended on the particular type of waste to be studied. A questionnaire on all the areas that had been given the lowest priority was created in parallel. Key persons in the projects were identified, and the researchers then made interviews with these 43 persons in the four projects.

3. Four groups of studied waste

Our classification of wastes is divided into four main groups: defects and inspections; non-productive use of resources; injuries and other ill-health problems; and waste due to systems and structures in the industry.

Defects and inspections. An obvious group of waste is defects and their consequences, i.e. defect costs. The hidden defect costs, i.e. costs due to defects that cannot be seen at site, are greater than the visible cost. Because defects exist, organisations create inspections in order to discover them in time and insure themselves in order to spread the risk in the case they occur. Theft and destruction of property are “defects” carried out by unauthorised persons and are thus included in this group. Our study shows that waste in this group represents more than 10% of a project’s production cost.

Non-productive use of resources. The second group of waste has to do with how the three resources of work time, machinery and building materials are used. The inventories show a surprisingly large portion of waste in the form of wait times, machinery that is not in use and material wastage. This waste corresponds to more than 10% of a project’s production cost.

Injuries and other ill-health problems. Waste associated with work-related injuries and illnesses is so large that we have chosen to report it as a separate group. The companies in a project have direct costs for health and safety. The largest cost is, however, for rehabilitation and early retirements and this burdens projects indirectly via taxes. Waste in this group represents about 12% of a project's production cost.

Waste due to systems and structures. The fourth group is waste in management systems among federal authorities, companies and projects and in organisational structures, e.g. in the industry, in companies and in projects. The types of waste reported in this group correspond together to about 5% of a project's production cost. However, we believe that this group of waste is the one most underestimated in our study.

4. Four general obstacles

The building sector has a great potential for improvement and cost reduction. To utilise this potential the sector must tear down a number of obstacles. We discuss four obstacles here.

There is a broad opinion that each building project is unique, that the building sector is different from all other sectors and that the building sector is conservative. These ideas come up constantly in debates and seminars, and sometimes in trade newspapers and the scientific literature as well. The first obstacle to development is that the building sector convinces itself that it is not possible to work smarter.

Most companies in the building sector claim that they are customer oriented and that they focus on the customer. This may be true for how companies take consideration to and translate the customer's needs into qualities in the product. But it is hardly true for how companies use the money they receive from the customer. The problem is to get those who are active in the building sector – primarily in projects, but also in companies and interest organisations – to realise that the expenditures for their work in fact burden the customer's budget. This weakness in customer focus is the second obstacle to utilising the entire potential for improvement.

The improvement work that individuals, groups, companies and industries initiate and conduct is well meant and its purpose is in different ways to produce better buildings at a lower cost. However, a review of different forms of improvement work shows that they often lead to a greater amount of administration and higher costs. New documents and activities are added to the process, but few old documents and activities are taken away. The third obstacle to utilising the improvement potential is that improvement work – in spite of good intentions – often works against its own purpose by increasing administration.

In carrying out this study we have seen how the building sector's structure with many actors splits up the process and contributes to creating administration whose usefulness to the end customer is unclear. Let us look at two principal development scenarios: horizontal and vertical development. In horizontal development, groups of actors, e.g. trade organisations, and labour union organisations, strengthen their respective roles. These groups act to introduce new kinds of training, new systems, new models, new plans, new documents, new roles etc. for the purpose of improving the situation for their members. The effect of this is partly that waste grows and partly that it contributes to conceal the main process of the building project. The second scenario, vertical development, means that actors together try to strengthen the value-adding main process and make it more effective. Partnership is a recent example of vertical development, often between the client and the building contractor. Our understanding is that there are many good examples of vertical development according to the second scenario. However, in our judgement, horizontal development according to the first scenario has been strongest in the past decades. This development thus contributes to successively increasing the amount of waste and consequently represents our fourth obstacle to sound development.

5. Conclusions

The study shows that there is a sweeping amount of waste – at least in the order of 30 – 35% of a project's production cost, although with a certain variation between projects. The greatest proportion of the waste is hidden to the majority of actors. It is thus important to make as much of this waste as possible visible.

One learning is that it is important to consider the entire production cost which the client has to pay for and not only the costs appearing at site. By having a client perspective and studying the entire production costs, and not only the costs appearing at site, means that several previously often overlooked wastes are revealed.

Competitive advantages for contractor by implementing new materials?

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Nowadays, price competition plays a dominant role in the construction industry in the competition to acquire orders. This leads to companies extensively striving for cost leadership in their competitive strategy. Therefore contractors almost simultaneously attempt to implement various cost effective optimizations of their processes. In this paper we would like to address the question whether contractors can gain a competitive advantage by using innovative materials or not. We will show if innovations of suppliers result in differentiation potential or cost advantages to obtain contractors' competitive advantages using the example of the materials fiber-reinforced, self-compacting and high-strength concrete. Furthermore we will analyze and assess in depth the impact of the contrary strategic objectives of supplier and contractor to obtain competitive advantages.

Keywords: price war, corporate strategy, material innovations, competitive capacity, competitive strategy.

1. Introduction

Apart from the market structure of the construction industry, the conflict of objectives between contractors and the suppliers also turns out to be a fundamental problem in the differentiation of the individual contractors in order to obtain competitive advantages through material innovation. While contractors try to act as the only supplier of an innovative technique in order to differ from the mass of competitors, suppliers attempt to sell great quantities and, by this means, to realize great profits.

If we want to analyze options of increasing the competitive ability of construction companies in order to obtain competitive advantages from supplier innovations, we need to study the following aspects in more detail:

- What development potential does the construction market offer, if any?
- What strategic options are available to construction companies to develop competitive advantages?
- What influence do suppliers' service and product innovations generally have on the competitive ability of construction companies?

In order to fundamentally understand the impacts of supplier innovations on the competitive ability of construction companies, it is necessary to analyze the corporate objectives of both supplier and construction companies, their interaction, and the benefit for the client. An examination of the technological, construction management and economic impacts is conducted in this paper using three innovative materials - fiber-reinforced, self-compacting and high-strength concrete – as examples.

2. Strategy options for contractors

Each construction company has different strategies as to how it wants to evolve with the probable potential in the local or international construction marketplace. The company's mission statement and values play an important role when it comes to selecting a company-specific strategy. But other factors, such as proprietary resources or the development of the overall market also need to be taken into consideration.

Plinke [3] indicates three basic types of strategic decisions, "Strategy cementation", "Growth strategy" and "Strategic restructuring". These three basic types are enhanced by "Strategic downsizing" as this can offer a sensible alternative in certain market situations.

A company uses a market strategy to define how it wants to position itself in the marketplace. A distinction must be made between market strategies that are chosen for the company as a whole, and those chosen for individual strategic business units (SBU). The company should aim to use its market strategy to generate a growth path in order to sustain its value. The dimensions of services / products and market as defined by Ansoff [1] are suitable for business units.

Based on this market strategy, the competitive strategy developed by Porter [4] illustrates the various ways in which a company can use its own efforts to create competitive advantages and differentiation potential from the client's perspective in the industry environment. Both the behavior vis-à-vis the competition and the resulting impact on the client need to be taken into account.

3. Impacts of innovative products on the players in the value creation chain

Although each new material represents a product innovation for its suppler (in this case the concrete industry), its impact on the other players in the value creation chain - companies and clients – depends on the type of change it effects to the downstream value creation phases [2] (Fig. 1).

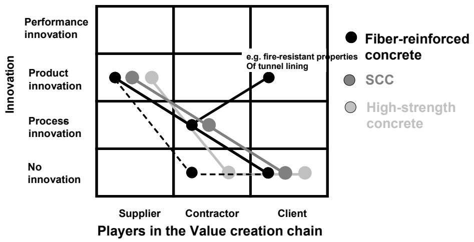

Fig. 1: Innovative products and their impact on the players in the value creation chain

For a construction entrepreneur, fiber-reinforced concrete only represents a process innovation if it eliminates the need for mat reinforcement during the performance process, since the process of producing the reinforcement mat then becomes superfluous.

Clients are only interested in results, and not in processes. If an industrial floor is being produced, the client's only interest is that the floor does not crack or sag and its durability are ensured. He does not care whether this was achieved by reinforcement mats of fibers in the concrete and will therefore not see it as an innovation.

If, in contrast, the use of plastic fibers substantially improves the fire-resistant properties of tunnel shells, this would represent a product innovation for clients, since the tunnel shell becomes safer for the users.

Certain measures need to be implemented when using SCC. The formwork has to be stronger, the workers have to be trained, and there is no longer any need for compression using mixers during the actual concreting process. As such, SCC represents a process innovation for construction entrepreneurs.

The new and improved effects of products manufactured using these innovative materials are not apparent to clients. Although they benefit from the possibly improved quality, they do not recognize these benefits at first glance, and as such these products are not genuine innovations for them.

The same applies to the use of high-strength concrete. The suppliers' product innovations do not have a tangible impact on the manufacturing and processing processes. With the exception of a few special circumstances, clients will not notice that an innovative construction material has been used.

4. Conclusion

The market structure of the construction industry coupled with the conflicting goals of construction companies and the construction materials industry are proving to be a fundamental problem when differentiating individual construction companies from their competitors on the basis of material innovations. The construction materials industry is characterized by an oligopolistic, nearly monopolistic supply structure, whereas construction companies with their atomistic supply structure and perfect competition among their peers having to deal with the forces of their clients and suppliers. This conflict between companies and suppliers is also underlined by the differing objectives of the two parties. Construction companies are trying to position themselves in the market as sole supplier of an innovative technology in order to prove to clients their differentiation from the competition and to set themselves apart from the crowd of atomistic suppliers, whereas suppliers try to generate large volumes of sales, large revenues and large profits and, to do so, to supply as many construction companies as possible with the same product. Following the relatively short launch phase of new materials, the competitive advantages for the individual companies in the marketplace are more or less lost, and perfect competition is re-established. Most construction companies will subsequently pursue a strategy of cost leadership. These relatively short cycles highlight the fact that the use of new and innovative materials cannot be expected to result in any lasting improvement of the competitive situation, nor, in consequence, of the economic situation of a construction company.

References

[1] Ansoff, Igor: Corporate Strategy. Verlag moderne Industrie, München, 1966.

[2] Girmscheid, Gerhard; Hartmann, Andreas: Innovationsmanagement in Bauunternehmen. Bautechnik, Band 80, 2003.

[3] Kleinaltenkamp, Michael; Plinke, Wulff: Strategisches Business-to-Business Marketing. Springer-Verlag, Berlin, 1999.

[4] Porter, Michael E.: Competitive Advantage. Free Press, New York, 1985.

Scenario studies to define the future needs of the clients and to design adaptable buildings

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Buildings are outdated before the end of their technical life. But we consider demolishment of buildings unacceptable in an environmental careful society. Therefore buildings must be designed for adaptation to unknown future needs. Scenarios are a helpful instrument to predict the future. It is a systemized way to predict the future based on developments in the past. But it is more then just continuing the lines from the past into the future. Drivers should be identified and understood. Drivers that may be discontinued or accelerate.

Keywords: future studies, scenario's, construction, adaptability

Introduction

Most buildings must be adapted to new needs during their life-time. To survive in the XXI century construction industry should develop a vision on the future of housing and business. It should be able to build for a predictable future need. Scenarios are a helpful instrument to predict the future. It is a systemized way to predict the future based on developments in the past. But it is more then just continuing the lines from the pats into the future. Developments should be understood. Their drivers should be identified. Drivers may discontinued or accelerate.

Scenario 1, Population growth

One most important scenario is about the development of the population. For some European nations the growth of the population came recently to an end. Others will soon reach that turning point. It is likely that in some decennia the building stock is more than required. The construction industry will by then only construct new buildings to replace outdated ones. After many years of turning green fields into brown, brown fields have to be turned into green fields again. For the Netherlands, my country, the population grew between 1900 and 1950 from 5 to 12 million. By the year 2000 we reached the 16 million milestone. It is uncertain whether we will tip the 17 million mark, but after that we certainly will go down.[1] In 2050 the result may be a population of 10 to 20% below the top. For city planers the consequences are important. If we build to house and service all people at the top occupation we will have a considerable number of useless buildings and over dimensioned infrastructural works after one generation. To prevent the construction of buildings that serve only during a limited time we must well in time change the production to more temporary facilities and make a scenario for the planned deconstruction of areas. If we do not do so, most areas will once be an undesirable mix of occupied and unoccupied buildings.

Scenario 2, Employment

A second scenario we need is about employment. The cost of personnel with permanent contracts is already considered to be high and gets usually higher and higher with every new or improved social law. As a consequence employers prefer temporary staff over permanent staff. On the other hand employees do not feel comfortable with ever increasing premiums to be paid for social security. These make many laborers reluctant to seek fixed employment contracts. We observe already a tendency to a growing number of self-employed people. Tele-workers are just like self employed workers seldom found at the companies head quarters. An employment scenario is important to enable real estate developers to make decisions about future needs for offices, factories and infrastructure. Self-employed people are usually evading the rush hour. Tele-workers don't travel at all for work. This may reduce the need for new roads and rail links. Self employed people and tele-workers live in houses with a small but professional office space. For the construction sector this will cause new markets. Meanwhile the demand for stand alone office space will decrease. [2]

Scenario 3, Environmental policy

The so called "Zero-energy-house" will once be the standard. The industry will develop equipment and systems to meet the higher standard. There is already an ongoing development in solar panels, photovoltaic cells, wind turbines and energy storage systems. These systems will be inevitable components in the buildings of the near future. Again the construction sector needs scenarios to foresee and prepare for the needs that come together with a new energy policy. Here not just the development in environmental awareness should be predicted. Even more important will be the development in the consumption of exhaustible resources like petrol and gas. But not only energy will be in short supply. The use of all other exhaustible resources will also be restricted. Demolition of buildings will be replaced by deconstruction. That is taking a building apart piece by piece. All the elements used in the construction process may be returned to the original suppliers for small scale separation into components and basic materials. The construction industry has to change the design process from design for eternity to design for deconstruction.

Scenario 4, Technologies

One more scenario should be written. It is about future technologies. Apart from the technologies mentioned under scenario 3, technologies that we know already or at least that we can imagine, other technologies may be developed. Technologies that go far beyond our most futuristic imagination. We should be aware that when in the nineteenth century our ancestors lit their houses with candles nobody could imagine of a future with electric light. While the only communication was by courier, nobody could even dream of any other system. Though we cannot predict all new technologies, we can determine some drivers for change. Restrictions on the use of fresh water for flushing toilets may in future encourage the development of a new technology for toilet cleaning. Recycling of waste water is in that case the first alternative. But the sound frequency systems used in laboratories and hospitals to clean equipment could be the alternative technology to go for. Also laundering of clothes and dish washing could use this sound based technology. [3]

The future will be unlike the past

One may presume that continuing the development from the past into the future is enough to write scenarios. A simple example can show how untrue this assumption is. In 1900 houses were building without any infrastructure for services. Toilets were build in the backyard. Sewage was collected in barrels. Lighting was provided by candles. Houses were heated by a fire. Cooking depended on fire as well. Communication was by writing and voice. So there was no need for any mechanical or electrical provisions in the house. This al changed dramatically. Houses are now filled with an ever increasing number of cables, ducts, and pipes. Drawing on this past experience we may decide that more shafts and empty ducts may be the way to meet future requirements. But just now the development turned the other way. Communication does not depend on cables any more. Computers, telephones, control devices and sound systems are now a days wireless systems. New wireless technologies are hindered by steel sheets and heavy reinforced concrete. Factors that was not relevant till recently. One day the zero-energy house will not need central power supply. Central supply may not be available any longer. Less likely but not to be excluded is discontinuation of central sewage disposal systems. [4]

Effect on construction

All future scenarios mentioned above will show developments with a great impact on the needs of the clients of the construction industry. The study described here is based on a limited number of publicly available data. Further investigation is needed to write all inclusive scenarios. Without such scenarios the construction industry will continue to build for the past. Houses and offices suitable for the needs of the day and with some provisions for continued developments in the same direction as we went already. Performance specifications will once reflect the changes described above. Our problem is that we now a days design for future needs, assuming that existing trends will continue in the same direction as before. So we design for ever more cables and ducts, while some scenarios indicate a development for less cabling and ducting. Fully new developments like the self employed society are not at all taken into consideration by designers and professional clients.

Conclusion

The new century will confront us without doubt again with new technologies and new requirements. We should not again have to modify inflexible buildings. The construction industry must invest in scenario development and should design buildings that are able to accommodate the most likely future needs.

References

[1] www.cbs.nl
[2] www.eib.nl
[3] Kendall, S. (editor), Open Building Implementation, 11th Annual Conference, Tokyo 2005, Page 119-15
[4] ICB Management Consultants, Bouw en Electrotechniek in 2015, (Dutch), Rotterdam 1996

The correct use of marble and stone in cladding: the BIAN.CA. Project

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The use of marble and stone in cladding requires deep knowledge: some examples show problems due to their incorrect use and send a message of complexity and there is the need to know their behavior. The BIAN.CA. Project, concluded in Massa Carrara by IMM, suggests a survey of the preservation of buildings realized with Apuan Alps' white marbles, to create a data base with a schedule realized by the major local companies. It was difficult to create it, but however the result was an efficient tool of analysis, useful in the future to focus the problems and to face them.

Keywords: marble and stone, claddings, correct use, BIAN.CA. Project., IM

1. Introduction

The marbles and the stones are very traditional, precious and fascinating materials, they are deeply linked to our building traditions and perfectly adapted themselves to the processing and building technological evolution through the centuries. The stone materials' most significant application in architecture is the use in external cladding, that requires deep knowledge of them and of the more advanced anchoring technologies too, in order to obtain correct results through a conscious design. There are, in fact, a lot of examples that show the problems due to the incorrect use of the stone materials, such the Finlandia Hall in Helsinki, the Amoco Building in Chicago and the Grand Arche in Paris. These projects send a message of failure, of excessive complexity, and of risk too, of the application of stone materials in the façades and in the envelope's systems, but around the world there are a lot of examples of buildings built using marbles and stones that had no problems during decades and a lot of projects that have been recently realized in the correct way. There is, then, the need to know the real behavior and resistance of marble and stone in such utilization, to address the choice of the materials by the designers and by the contractors, with the strategy to increase the value of the services offered by the companies in this sector.

2. The BIAN.CA. Project

The BIAN.CA. Project, recently concluded in Tuscany Region in the province of Massa Carrara (that with the province of Lucca forms the stone Industrial District) is a Regional project: BIANCO DI CARRARA Environmental safeguard through correct use of external claddings. The programs that supported this project are the DoCUP Objective 2 2000-2006 (Measure 1.7 "Transferring of the innovation to the PMI") and PRAA 2000-2006 (Action D21 "Actions of system for research and innovation"), proposed by IMM-Internazionale Marmi e Macchine Carrara S.p.A., that also organizes Carrara Marmotec, an important fair in the stone sector. The objective of the Project, entirely coordinated by IMM, is to prevent the use of some types of Carrara marble that in external claddings loose their mechanical characteristics and have to be removed and substituted with costs' increases and problems of image. This objective was quite the same of the one of the projects MARA and TEAM promoted by European Community, that didn't achieve satisfactory results. The BIAN.CA. Project suggested to realize a schedule, to be publicized among all the actors of the building process, which defined the information to acquire to consider the parameters that influence the behavior of the cladding. Using this schedule the Project provided for a very detailed and deep action of survey of all the buildings realized in the last years with Apuan Alps' white marbles, of their state of preservation and of the possible intervention of substitution of some slabs and panels. All the information collected in this way would be used to create a wide and flexible data base, useful for all the statistic and technical studies in necessary in the future to define the problems and their causes. The objectives of the BIAN.CA. Project in detail were:

1. Create the net of the partners and involve more companies;
2. Coordinate the work;
3. Implement the scheduled activities;
4. Individuate the subjects to be involved in the next phases of the research;
5. Realize an executive program for the next activities of research;
6. Realize and actuate a plan of diffusion of the objectives (at the start) and of the results (at the end);

3. Organization

The partners involved were coordinated by IMM as leader and they were chosen among the major local stone companies and, with the contribution of their technical consultants (among them the author of this paper), had the task to analyze the problems of the use of marble in external claddings and to realize a complete and exhaustive schedule in order to run the survey. These companies were Adolfo Forti Marmi S.p.A., Barsimarmi S.a.S., Bertozzi Felice S.r.l., Co.ge.mar S.r.l., Corsi & Nicolai S.r.l., Euromarble S.r.l., Ezio Ronchieri S.p.A., Henraux S.p.A., La Facciata S.r.l., Marmi Carrara S.r.l. and Savema S.p.A.. The technical staff of IMM organized a series of meeting in order to proceed to the drafting of the schedule, considering all the different aspects of the problem, seen from different points of view. These meetings were very important especially for the exchange of experiences that were very different according to the dimension of the company, of its management and of its technical office or consultants, to the specialization in the quarrying of particular materials or in the trade in specific markets, to the processing techniques and to the existing job contacts with big and important architectural studies and societies of engineering around the world.

4. Schedule

The first part of the schedule deals with the site of the building and with its prevalent weather condition, in order to know if the possible problems come from an incorrect choice of the material according to them. Then are requested information about the building and the project, to exactly visualize the way the stone was used and to establish a direct link with the designers, not straightly included among the partners. The second part of the schedule is about the general information about the material: it is very important to know the technical characters to focus the possible cause of the problem. Very significant are the petrographic definition according to the norms (EN 12440), in order to avoid confusion and to exactly define the type of the marble, and the possible tests according to EN, UNI, ASTM or other norms. An important aspect is the possible material of support (honeycomb, alucobond, glass or carbon fibres, epoxy resins, steel). Very important are, then, the dimensions (especially the thickness) of the slabs, the modules, the processing and the surface treatments. The third part of the schedule is about the type of the façade and of the structure of the building, the typology of system and of anchorage, the material and the model, if it is built in industrial way, the type of the connection to the structure and the position on the slabs. Very important is to know who made the assemblage because an incorrect one can nullify all the previous operations. These information about the anchoring system are significant because in the past it was one of the weak points of the façades for the use of wrong materials and the not industrial production. In the last part of the schedule are described the problems and the action taken to try to solve them. The schedule is also completed by drawings of the buildings, schemes of the anchoring system and of details of the anchorage.

5. Conclusions

The BIAN.CA. Project started in February 2005 and ended in July 2005 and in the last phases the staff of the IMM and the partners of the Project couldn't fill in a significant number of schedules because of the very low consideration given in the past to these aspects of the organization of the building process. The expected data base couldn't be organized, but however the Project led to a very important result with the realization of this schedule which collects the experience and the professionalism of IMM and of important companies in the Apuan area, known in the world as the centre of quarrying, processing and trading of stone materials. This schedule represents the vitality of the entire Apuan industrial area and its intention to react to the crisis of the sector: it is a very efficient tool of analysis, probably the first ever predisposed in this direction, and it has to be diffused, in prestigious occasions like this Symposium too, to create real competences among the designers and a new culture of the stone. Waiting for these future developments, the schedule it is very useful for the survey of new buildings, in order, in the next years, to create a real data base of the problems related to stone claddings, to focus and correctly face them.

References

[1] Acocella A. (2004) *L'architettura di pietra. Antichi e nuovi magisteri costruttivi.* Alinea Editrice, Firenze.

[2] Detail 7 (2001) *Facades* Institut für internationale Architektur-Dokumentation, München.

[3] Detail 11 (2003) *Building with stone* Institut für internationale Architektur-Dokumentation, München.

[4] Fioraso M. (2004), *Facciate a secco. Aspirazione progettuale e realtà dell'installazione., Atti del convegno "L'involucro edilizio: innovazione e sostenibilità",* Fiera del Levante, Bari.

[5] Lucchini A. (2004) *Evoluzione delle pareti ventilate: sistemi e materiali, progetto e messa in opera., Atti del convegno "L'involucro edilizio: innovazione e sostenibilità"*, Fiera del Levante, Bari.

Marketing practices in the Chilean construction industry: preliminary findings

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Some of the key factors for a profitable performance of construction companies are a good understanding of clients' needs and their satisfaction. In this sense, marketing plays an important role. However, the marketing concept is not widely applied today in the Chilean construction industry. An exploratory study about marketing practices in the Chilean construction industry was carried out recently. The main results of the study were an exploratory analysis of the current status of the marketing function in construction companies and the proposal of a methodology to help them to initiate or enhance the application of marketing. The main conclusion of this preliminary study is that there is a lack of understanding and knowledge about marketing in the Chilean construction industry. Because of this situation, many construction companies ignore this useful management area although many of them do apply marketing practices in their activities without realizing what they are doing.

Keywords: marketing, Chile, construction industry, management.

1. Introduction

Currently, an increasing level of competition is seen in the national construction industry due to the participation of many foreign and new domestic construction companies. Besides the competition, construction companies are threatened by the dominance of the lowest price in the selection of a contractor and the low level of knowledge that owners have of the benefits of a good contractor's selection. Then, one of the key factors for construction companies is the knowledge of clients and the achievement of their satisfaction with superior competitive offers. Thus, marketing, as a function that deals with all the activities that are related to markets and clients, can greatly contribute to the competitiveness of a construction company. However, marketing is a discipline not well known in the domestic construction sector and there is the feeling that its application would not be very profitable for a construction company.

2. Marketing in construction

Marketing in construction consists in a set of activities: finding new markets; evaluating the potential of a job; establishing contacts with potential clients; obtaining information about market conditions, potential clients and projects; estimating projects' cost; issuing proposals; participating in contracts; negotiating changes and claims and the development of new technologies and contract schemes [1]. Thus, marketing is the process through which construction capacities are related with clients' needs. This is why construction companies spend a great proportion of their effort in marketing activities, even though many of the companies would not recognize this due to the fact that they do not understand the scope of the marketing function. The construction industry has been quite slow in recognizing the advantages of marketing as a tool to improve the performance in terms of market share, sale levels or profits. According to Hillebrandt and Cannon [2] the reason of the above is based on the fact that for a long period of time, the work load in the industry rose gradually and for this reason construction companies never had over supply problems. Marketing and promotion are somewhat recent developments in the management of construction companies. Research efforts have found that there exists a substantial misunderstanding about what is marketing and how should it be applied. In construction companies, marketing not always provide the necessary support to the business management and seems to be not integrated with the other business functions like production or human resources management [3].

The market will force changes in the construction industry. The winners will be those that are able to promote and embrace change. The idea is to attempt to change the image and the nature of what is provided at the eyes of the client. However, this will not be easy due to two main factors: the importance of price and the required investment in marketing and promotion.

3. The Chilean construction sector

The GDP of the construction industry has averaged 8.4% of Chile's PIB during the last ten years. Construction GDP is strongly correlated with the country's GDP as shown in figure 1. During the year 2005, the construction product reached the amount of US$ 9,600 million. It is estimated that there are between 3.000 to 4.000 construction companies in the whole country.

Regarding competition in construction, there are some special conditions that negatively influence the domestic construction industry as follows:

- Clients do not have reliable information about contractors' performance and quality. In many cases they do not have the required competency to manage and control the design and construction stages. Due to this fact, price is still the major criterion for contractor's selection.
- Construction companies do not have a clear knowledge about their potential clients and future market development.
- Contracting relationships are prone to conflicts between parties due to the fact that there usually are many design deficiencies and a lack of management skills.

4. The construction marketing study

A qualitative research approach was used to find out about marketing activities in the construction sector [4]. This approach was selected due to the fact that it was intended to capture the visions and perceptions of top executives of construction companies. This was the first study on this topic and was of exploratory type. A semi-structured questionnaire was designed and applied during the information collection stage. A total of 21 construction companies were contacted but only 11 of them accepted to participate in the study.

From the information obtained in this study it is possible to conclude that construction companies provide an almost total homogeneous service for every market segment. There is almost no differentiation within each segment and price is the only differentiation factor. Companies do not carry out specific actions to position them in each market.

It calls the attention to see that market studies about clients do not exist. There is no information about companies' market share in the different market segments.

Another conclusion is that the majority of the companies believe that they do not apply marketing. However, all of them do realize activities that are part of marketing but they do it in an intuitive, unstructured way. Only half of the companies consider the possibility of integrating marketing in their management functions in the future. From the study, the following weaknesses have been identified in Chilean construction companies regarding marketing:

- Lack of strategic planning.
- Clients are not included in the definition of companies' mission or vision.
- Construction companies do not know the real meaning of marketing.
- Marketing is not integrated into the organization philosophy.
- Companies that work with more than one segment do not offer a service adapted to the clients of each segment.
- Companies do not define a marketing mix for each target segment.
- The potential of promotion is not fully exploited.
- Companies are only concerned on competing by price.
- Companies do not realize studies to know which characteristics of the company are the ones that actually attract their clients.
- There is no differentiation in their offer. The provide service becomes a commodity.
- Companies do not develop actions designed to create clients' loyalty.
- Companies do not obtain clients' feedback systematically.
- Companies are reactive in front of their competitors and do not monitor them.
- Companies do not have a strategy to position their brand and image.

References

[1] Arditi, D. and Davis, L. (1988) Marketing of Construction Services. Journal of Management in Engineering, Vol. 4, Nº 4, October.

[2] Hillebrandt, P. and Cannon, J. (1989) The management of the construction firms. Macmillan, London.

[3] Langford, D. and Male, S. (2001) Strategic Management in Construction, 2nd ed. Prentice Hall.

[4] Quintas, P. (2003) A critical analysis of the marketing function in construction, M.Sc.in Engineering Thesis, Pontificia Universidad Católica de Chile, Santiago.

The role of the construction industry in the development of Turkey

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The construction industry plays leading role in the development of developing countries. Being Turkey a developing country, in this paper the role of the Turkish construction industry in the development of Turkey was analyzed as a case study. Being labor intensive, construction industry plays an important role in solving high unemployment rate problem in Turkey. The construction industry has an important affect in the development of construction related industries because of its need for various inputs from other industries. The research was conducted based on the literature survey.

Keywords: construction industry, construction related industries, developing countries, the role of the construction industry in the development of the countries

1. Introduction

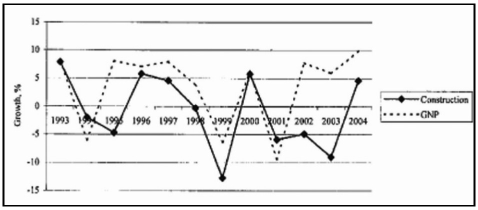
Turkey's economical situation has changed since its establishment. From 1930s until 1980s, Turkey followed import-substitution industrialization politics by means of public enterprises and development planning [1]. Turkey began to develop rapidly after 1980 with the shift into liberal market economy. "…Real GNP growth was more than 6% in many years. However, this expansion was interrupted in 1994, 1999, and 2001. On the other hand, in 2004, GDP growth reached to 9%. Inflation fell to 7.7% in 2005 –a 30-year low…" [2] In the early 1990s, the industry's share in the economy was aimed to be increased by promoting export [3]. The unemployment has been a problem in the Turkish economy throughout the years.

2. Construction sector

The construction industry is one of the important and locomotive sectors in Turkey. "The construction sector is the third largest sector in Turkey after the food and textile sectors. Many Turkish construction companies carry out both domestic and international projects.

"The construction sector has 6 percent share in the country's GDP. However, taking into account the sub-sectors which are in relation with construction, the share of construction in GDP is approximately 30 percent. The market size of the sector was $11.4 billion towards the end of 2004. The sector shrank after 2000, due to the economic crises. In the years between 2001 and 2003, the sector shrank 5.8, 6.3 and 9.3 percent. In 2005 the growth rate of the construction sector surpassed the growth rate of Turkey's GDP [4].

The growth in the construction sector in Turkey is affected by; like population growth, urbanization, renewal of houses not built in line with regulations, inflation and interest rates. [4].Based on Turin's research in 1973, there is positive relationship among the value added in construction sector and economic growth [5].



Resource: State Institute of Statistics [6].

Figure 1. Comparative Growth in Construction and GNP

In 1980's construction sector grew rapidly in Turkey. The trend of growth slowed down after 1988. There are two main reasons for this: the decrease in the investments in infrastructure slowed down towards late 1980's… High interest rates increased the cost of investment which caused decrease in the demand of construction and increase in the financial cost of the contractor. Construction investments of private sector were in decrease in the period of 1998-2003. In 1996 the share of construction in GDP was 11%. In 1993-2000 period the employment in the sector was 1.2/1.3 billion. In case the population of a family is considered to be 5 people, this means that the sector provides employment for 7-8% of the population. The share of construction in GDP fell to 3.9% in 2003. The decrease in 2003 was especially caused in 1995, 1999 and 2001. In these years, Turkish economy was in recession because of the earthquake and economic crises. The recession in construction is normal to be observed. However, even though Turkish economy started to grow, after the crises, the construction sector only continued to be in recession. Only after the earthquake in 1999, the sector could recover in 2000. The recession in the sector was also caused because of the decrease in demand in international market. One of the reasons of this recession was the decrease in the public sector investments. There is parallelism between public investments and the value added in construction. In Turkey, the share of construction investments in total investments fell from 60% to 45%. In 1988-1998 period, the export increased with the residential and industrial construction production. In 1990's the increase in budget deficits and in public debts resulted in the savings in public sector. [5].

In the third five year development plan (1973-1977) period the value added in construction sector was around 5.8. This ratio increased to 6.7.2 in 1978-1981 period. Following 1980, the decrease in the value added of the sector was seen. In 1986, this ratio increased. The share of the construction sector and the sectors providing input to the construction in the economy was approximately 40%. In 1980, the share of the construction in GNP was 6,3%. In 1986 it was 5,6%. The growth rate of the construction was 4,2% in 1979, 0,8% in 1980; 0,5% in 1980; 0,5% in 1982; 0,6% in 1983; 2% in 1984, 3% in 1985.

3. Conclusion

The construction sector and Turkish economy are closely related. Unemployment is one of the biggest problems in Turkish economy. Being construction sector labor intensive, it helps the employment of labor force. This in turn affects the well-fare of the families too.

The development of construction sector in Turkey and the development of Turkish economy affect each other. Construction sector and the material industry are affected by the crises in the economy.

The construction industry has an important role in the Turkish economy and in its development. "The construction industry's share in Turkey's total GNP is 5.8%. Construction investments cover the 60% of total fixed investments in Turkey. The share of public construction investments in this proportion is 30%.

The construction industry provides employment to about 1.4 million people, representing 6% of the total employment in Turkey. The number of people employed in the industry increases when unregistered employees considered.

Turkish contractors have a significant share in the total construction work in overseas markets. The share of Turkish contractors in the international market reached 4% in 1998 with a total amount of US$39 billion. The construction industry meets basic human needs by creating the necessary built environment and physical infrastructure in domestic and foreign markets.

In conclusion, Turkish construction industry was affected by the general economic fluctuations and development trends of the country. However; the construction sector meets the construction requirements of the country's other sectors. It contributes the economic development of the country. At the periods of growth, it helps reducing the unemployment rate as it is labor intensive industry. On the other hand, in the period of crises, the construction industry was negatively affected. This in turn resulted in increase in the unemployment rate of country.

The construction sector has the major importance for the country's economy to create added value, and to maintain the sustainable employment rate for the benefit of the well fare of the people. With the lack of the construction sector, country's sources might not be enough to meet the construction requirements in growth periods and the development of the country might have paused and even could not been achieved. It can be stated that the construction sector plays vital role in the development and well fare of Turkey. It helps maintaining development and economic stability.

References

[1] http://lcweb2.loc.gov/cgi-bin/query/r?frd/cstdy:@field(DOCID+tr0061

[2] http://www.indexmundi.com/turkey/economy_overview.html

[3] http://lcweb2.loc.gov/cgi-bin/query/D?cstdy:4:./temp/~frd_MT2Z::

[4] http-//www.buyusainfo.net/docs/x_2332910.pdf 15 May

[5] Güneş et al. (2004) *İnşaat Sektöründe Stratejik Planlama*, TMB Yayınları

[6] Oner, M.A and Saritas, O. (2005) *A systems approach to policy analysis and development planning: Construction sector in the Turkish 5-year development plans* Technological Forecasting and Social Change 72, pp. 886-911

A study of the role of leadership characteristics of women in construction

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The leadership is defined as 'the ability to influence – either directly or indirectly – the behaviour, thoughts, and actions of a significant number of individuals'. Organisations have paid attention to leadership styles of their people who occupy managerial positions, holding the belief that leadership is an important factor in achieving business success. In the construction industry, in particular, it is difficult to determine the most appropriate leadership style because of its unique characteristics. Although mainstream research on leadership generally continues to ignore gender relations, over recent years there has been major expansion of international research on gender relations in leadership, organizations and management. Previous studies have found differences in leadership styles in terms of gender and managerial hierarchy. In this context this paper examines the literature relating to the leadership styles in construction with particular emphasis on the role of the leadership of women. The paper also presents a comparison between the different leadership styles of managerial personnel in the construction industry emphasising on the similarities and differences in leadership styles of construction professionals in terms of gender with a focus on leadership qualities of women and their suitability to construction industry.

Keywords: Women, Leadership, Construction.

1. Introduction

The issue regarding the lack of women in construction has been a concern for many years, attracting government and industry wide attention. This issue has been made more prominent recently due to the potential skill shortage facing the industry. The UK construction industry is busier than it has ever been for a decade and is suffering from skill shortage in both craft and professional level [1]. The industry cannot totally rely on the traditional male workforce to meet these targets. Therefore the UK government is examining ways to encourage women into traditionally male-dominated jobs. Thus recruitment of women is imperative to achieving these objectives and prolonging the industry's growth.

Having interviewed the professionals who are attached to construction industry the fact revealed was that we hardly get females in the recruitment panel of a construction organisation. Therefore, there is a high possibility of recruiting only male workforce to that organisation. Also lack of women role models in construction is a great discouragement for the females to choose a career in construction. These flaws can be overcome by encouraging more women managers into construction industry. It is realised that encouraging more construction women managers will in turn help to attract more women for other levels in construction. In this context this paper mainly looks into the leadership characteristics of women in construction.

2. Leadership in construction

The construction industry is, in any country, a complex of the economy, which involves a broad range of stakeholders and has wide ranging linkages with other areas of activity such as manufacturing and the use of materials, energy, finance, labour and equipment [2]. It is mainly project oriented where the project-based organization is disbanded upon the completion of the task. This-project based nature of construction industry with its temporary multi-organizations, will almost certainly have an important influence on the managerial leadership styles of professionals working in the industry [3]. The construction professionals need different leadership styles in different phases of the project life cycle. Naum [4] concludes that 'Leaders may thus have to switch from one style of leadership to another or combine elements of different styles until the right balance between concerns for tasks and concern for people is reached'. A proper team work is also essential in order to make everyone works towards a single goal. This could be achieved by appointing a good management with leadership qualities to control and influence the construction activities.

As this study focuses on women at managerial positions, it is important to take the issue of leadership into consideration. Because organisations have paid attention to leadership styles of their people who occupy managerial positions, holding the belief that leadership is an important factor in achieving business success [3]. In recent years, both mainstream management literature and organisational policy show evidence of a marked turn to leadership rather than management as the means to enhance organisational performance in contemporary organisations. This is matched by a growing trend in the UK to attribute ever-greater significance to leadership as a way of solving organisational problems not only within the private sector, but also within the public sector [5].

3. Role of leadership qualities of women in construction

Although mainstream research on leadership generally continues to ignore gender relations, over recent years there has been major expansion of international research on gender relations in leadership, organizations and management [6]. Previous studies have found differences in leadership styles in terms of gender. In masculine cultures, there is a higher emphasis on assertiveness and the acquisition of money and other material things. Feminine cultures stress relationships among people, concern for others, and interest in the quality of work environment [3]. Another researcher Marshall [7] has described “feminine” values as being characterized by qualities which include interdependence, co-operation, receptivity, merging, acceptance, and being aware of patterns, wholes and contexts.

As women have become a more prominent presence as managers and executives in organisations, more attention has been devoted to the possible differences between the leadership styles of women and men. The growing number of women in managerial positions created interest in the role of women as leaders [8].

The transformational, empowering and collaborative style of leadership associated with women is compared with the more directive and authoritarian style traditionally associated with male leaders.

Conclusion

Due to many barriers such as image of construction, knowledge of construction, recruitment procedures, etc. the women are under-represented in the industry. It is realized that the ignorance of women will not help to fill the skills gaps pertaining in the industry.

This paper mainly aimed to study the leadership characteristics of women in order to find out the appropriateness of the women into construction managerial positions where they are seriously under-represented. From the literature survey we can say that the transformational leadership could be the preferred leadership style used by women. But this statement still needs further research.

Based on these ideas arisen through literature survey the way forward for this research is to find out how the specific female characteristics are expressed in construction organisations and also to find out the consequences of expressing or undertaking female leadership in construction.

References

[1] Fox, K. (1998) Move over boys: In Equal Opportunities.

[2] Hillebrandt,P. (1985), Analysis of the British construction industry, Macmillan, London.

[3] Giritli,H., and Oraz,T. (2004) Leadership Styles: Some evidence from the Turkish construction industry, Construction Management and Economics, 22, Pp 253-262

[4] Naum, S. (2001), People & Organizational Management in Construction, Thomas Telford, London.

[5] Ford, J (2005), Examining leadership through critical feminist readings, Journal of Health Organization and Management, 19 (3), Pp. 236-251

[6] Hearn, J., and Piekkari, R. (2005), Gendered Leaderships and Leaderships on Gender Policy: National Context, Corporate Structures, and Chief Human Resources Managers in Transnational Corporations, Leadership, 1 (4), Pp 429-454

[7] Marshall, J.,”Viewing organisational communication from a feminist perspective”, in Deetz, S.A. (Ed.), Communication Yearbook, Sage, Newbury Park, CA, Vol. 16, 1993, pp. 122-43.

[8] Klenke, K. (1996), Women and Leadership: A Contextual Perspective, Springer, New York, NY.

Facilitating the risk management process in a large scale construction project using VR models

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Techniques and tools traditionally used in risk management include the application of checklists and brainstorming, which are often handled separately by the different parties on a project. The primary objective of this paper is to present the work process and gains from the use of VR models in risk management. A secondary objective is to present some findings on the adoption of collaborative working through partnering and to comment on its connection with the use of VR models in the risk management process.

Keywords: Risk management, uncertainty management, construction project, virtual reality, concurrent construction process

1. Risk management with use of VR models

The aim of the paper is to report on the risk management process as it has been applied to the MK3 project, especially the use of VR modelling. The primary objective is to identify opportunities arising from VR modelling as a tool for use in the risk and uncertainty management process and highlight essential improvements. A secondary objective is to present findings on the adoption of collaborative working through partnering and to comment on its connection with the use of VR modelling. This paper is one component of output from studies at LTU covering part of the MK3 project, albeit the most complex part in terms of the number of installations to be accommodated in the facility. It is also the part that is most critical to the project's success. The primary focus of attention in the study is the main contractor, NCC, and the client, LKAB.

2. The MK3 project

In 2004, the international minerals group LKAB decided to invest €290 million in a new facility, MK3, for pellet production. Keeping to a tight schedule was a major challenge for the project management group. LKAB started the bidding process without finalised documentation for the design and construction, and worked out the details as the project proceeded. Another task for the project management group at LKAB was handling such a complex and large project without jeopardising the functioning of the facility.

With these prerequisites in mind, the project management group took an early decision to carry out the project on the basis of collaboration through partnering and to use 3D technology to create a virtual reality (VR) model. The partnering concept would ensure that the whole project organization had the same objectives for the project, namely function and time. The project has worked with open books regarding economy and there have been incentives related to the objectives, function and time. There was no time to be wasted on conflict arising from the contract once work started. The focus was on solving upcoming problems not to argue about whose responsible they might be. The VR model was intended to ensure that complicated installations would fit together before they were placed within the facility. The model was also seen as a way of supporting early decisions on layout and construction of both the process and the facility. The main objectives of function and time meant that there was no room for mistakes: risk management and uncertainty management would have to succeed.

3. Risk management process

In the project, risks and uncertainties have been handled in many different ways. On a high organizational level, any changes in process or in layout are followed by a risk analysis.

During the planning phase, risks are closely coupled with the industrial process that is to be set up and the focus is on future production capacity. Given the importance of these factors, any risk that could jeopardize the function of the plant is considered and dealt with accordingly.

On the organizational level, risk management or rather uncertainty management has been a part of the planning regime, which has been a distinguishing feature of the project. The focus in planning meetings has been sorting out any uncertainty that could arise. The procedure has meant scanning through the VR model as drawings from the different consultants are released. Collisions and conflicts in the different areas gain visibility and can be sorted out before they materialise during construction. The number of conflicts discovered is very high, although not all are major. Nonetheless, they are still conflicts that, left unattended, could jeopardise the tight time schedule and thus the overall success of the project.

At the site level, close to the construction of the facility, risks are controlled by short term, detailed timetables and, to some extent, checklists. The compressed timetable and a concurrent construction process are critical for the project and represent the factors that set the scene for this complex project.

4. Conclusions

The context for this project has been collaborative working through partnering. It has been an important aspect of the risk and uncertainty management process. The concept of working under a partnering arrangement has enabled the different participants to be open about the uncertainties and risks found during the process.

The other important factor in the successful approach taken on this project has been the use of VR modelling. It has been a useful tool in support of the risk and uncertainty management process at two levels: identification and response. The major risk factor, the project's tight time schedule, set the boundaries for the project. The response in controlling this risk is having an advanced system to help; that has been the VR model. As one respondent put it, "instead of using 200 overhead copies on top of each other we now start with the VR model and use that".

The use of the VR model has also led to improvements in the working environment. Adjustments can be made at an early stage, using a VR virtual model, to ensure that the final process is as safe as possible for the people who are running it.

An interesting observation in this study is the transformation from risk management to uncertainty management. In the earlier stages of the project the handling of risks was more formal. The risks management process where well in line with suggested methods from theories in the field. An explanation for this is the organizational level where this work is taking place. At later stages in the project, closer to the worksite, the risk management can more be described as management of uncertainties.

Integrating the schedules (time) with the 3D models (4D CAD) for a complex project such as MK3 would decrease the number of uncertainties even more. The possibility to plan the time and space required for each and every subcontractor would have decreased the workspace conflicts in the project [1]. Competition of work-space between different crews slows down the productivity as well as it increases the risks for accidents on the construction site.

References

[1] Olofsson, T., Jongeling, R. Toolanen, B., Woksepp, S.,Simu, K. (2006) *Riskhantering och IT-stöd i stora anläggningsprojekt, en fallstudie av MK3 projektet.* Technical report, Luleå University of Technology

[2] Chapman, C. and Ward, S. (2003) *Project risk management: processes, techniques and insights*. Second ed. Wiley, Chichester

[3] Chapman, C. and Ward, S. (2003) *Managing risk and uncertainty: a constructively simple approach to decision making* Wiley, Chichester

[4] Ward, S. and Chapman, C. Transforming risk management into project uncertainty management, *International Journal of Project Management 2003, 21(2):p.97-105*

[5] The PMBOK handbook series vol 6 (1992) *Project and program risk management: a guide to managing project risks and opportunities*, Project Management Institute, Drexel Hill

[6] Flanagan, R. and Norman, G. (1993) *Risk Management and Construction*, Blackwell Scientific Publications, Oxford

[7] Jaafari, A. (2001) Management of risks, uncertainties and opportunities: time for a fundamental change, *International Journal of Project Management 19(2):p 89-101*

[8] Simu, K (2006) *Risk management in small sized projects*, Licentiate thesis, Luleå University of Technology, (to be published)

Synthesising emerging issues within key futures study reports in construction

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In the last decade, there have been a range of futures studies published by individuals and organisations within the construction sector and wider afield. Despite this, little work has been done on synthesising and classifying the emerging issues and analysing the substantive content of these studies. A thorough search of futures study reports in construction has been conducted from which key reports were selected to be examined in detail. Content analysis yielded 337 emerging issues, both internal and external to the construction industry which were classified under six major themes, namely 'technological', 'environmental', 'social', 'economic', 'governance' and 'construction industry'. The key characteristics of the issues including the possible inter-connectivities among them are explained. The paper is concluded with a brief discourse on our future research work in this area and the possible associated methodologies to be employed.

Keywords: competitiveness, construction industry, future issues, futures study

1. Introduction

There is a significant body of literature on futures studies. Generally, they look ahead or envision what the future will look like. These studies do not necessarily aim to predict what will happen, but aim to encourage thinking intelligently about the issues that will affect the future in order that they can be prepared for. This paper reports on the initial stage of a large multidisciplinary collaborative research project aimed at developing possible future development scenarios for the UK construction industry covering the next 20 years in order to support the industry in delivering the future requirements of society and industry. The research reviewed a number of future studies and reports in construction and identified issues and/or drivers which may influence and be pertinent for the future of construction. The paper discusses the preliminary findings as well as on-going and future work.

2. Analysing future reports in construction

These reports vary in aim, scope, areas of focus, stakeholder and time orientations. The research selected 13 of the most significant reports, which constitute a representative sample of many future construction related reports. Two key reasons of inclusion were firstly that the reports were published relatively recently (with publication ranging from 1998 to 2005), and secondly by their potential importance to the sector as assessed by members of the research team. Seven reports focussed on the UK ([1], [2], [3], [4], [5], [6], [7]), and two make global comparisons ([8], [9]). A number of construction futures reports from other countries were also included such as those from Australia [10], the USA ([11], [12]) and Europe [13]. The texts within these reports were analysed using content analysis. The analysis captured the content of the reports mainly in terms of ideas and issues which were considered to be important in the future or which are influencing the current positioning of the sector and which will continue to do so in the future. In total, 337 issues have been identified. These were initially grouped into six broad themes, namely technological, environmental, human, economic, governance, and construction industry specific. Twenty seven sub-categories were derived from the process.

3. Discussions and future work

Thinking about and planning for the future is a complex exercise. The reports reviewed in the research suggest that different people may envisage different pictures and indicate different factors/issues of importance. The issues collated in this research as reviewed in the paper display fragmented snapshots of the plausible futures. The issues themselves have many facets and dimensions. Some refer to potential events (e.g. act of terrorism, London Olympic 2012) and trends (e.g. growth in services, decline in manufacturing and agriculture, smaller (i.e. single parent) households); specific artefacts or tools (e.g. 3D technology, robot use); processes or practices (e.g. recycling and reuse of building materials, knowledge management); problems (e.g. pollutions, rising sea levels); measures or facts (e.g. demography profile, traffic volumes); and ideal outcomes or goals (e.g. improved quality of life, environmentally efficient houses). The scope of issues varies from those at operational level (e.g. building regulations, planning control policies) to those at abstract/ higher level (e.g. sustainability, urbanisation). Some are specific to the UK (e.g. North and South divide, cheap housing initiative £60k), Europe (e.g. ageing population, European single market), and global (e.g. climate change, greater outsourcing to low cost economies).

Although these reports identify and discuss a range of issues that might affect construction in the future, which is a useful exercise in its own right, they fail to address the complexities and uncertainties of both the present and the future, or to explore the connections between global, local, construction-specific and more wide-spread factors [14]. Furthermore, a 'good' or 'bad' future is contingent upon the perspective of the stakeholders. For example, 'global warming' might lead to stricter regulations, but also more development of infrastructures for introducing and exploiting alternative energy sources. It could also lead to a boom in the tourist industry and the emergence of wine industry in Britain. Inter-connectivities between these issues are crucial for generating a better understanding of the future and for building dynamic capabilities to proactively respond to the challenges ahead.

Future research in this project will develop maps of the complex interconnections between these issues. This would make possible a holistic view of potential chains of causal relationships which permit stakeholders of the future to introduce well-informed policies and intervention strategies whilst also considering their potential knock-on effects. The aim is to develop a number of alternative multi-level future scenarios based on verified future issues and validated interconnections between them, using a series of multidisciplinary workshops across various stakeholders concerned with the future of construction. The information produced through the research will be used to develop an interactive IT tool which can be used by industry stakeholders to simulate scenarios and enhance their abilities to think about longer time horizons. Rather than achieving a consensus, this will stimulate discussion, debate and raise questions amongst multiple construction stakeholders. This exercise could certainly bring positive benefits in terms of engaging the sector in processes to shape a better future for all. Ultimately, this could allow them to have better control over their own potential futures.

References

[1] CIRIA (1999) *Adopting Foresight in Construction*. Construction Industry Research and Information Association, London.

[2] Edkins (2000) *Summary Report on Key Considerations for Building Scenarios*. UCL / CRISP / Foresight, London.

[3] DTI (2001) *Constructing the Future*. Foresight report, Built Environment and Transport Panel, Construction Associate Programme. Department of Trade and Industry, London.

[4] Fairclough (2002) *Rethinking Construction Innovation and Research: A Review of Government R&D Policies and Practices*. DTLR, London.

[5] DTI (2002) *Foresight Futures 2020: Revised Scenarios and Guidance*. Foresight / DTI, London.

[6] Foxell, S. (ed.) (2003) *The Professionals' Choice: the Future of the Built Environment Professions*. Building Futures, CABE/RIBA, London.

[7] Landry, C. (2004) *Riding the Rapids: Urban Life in an Age of Complexity*. Building Futures, CABE/RIBA, London.

[8] Bourdeu, L., Huovila, P., Lanting, R. and Gilham, A. (eds.) (1998) *Sustainable Development and the Future of Construction: a Comparison of Visions from Various Countries*. CIB Publication 225, Rotterdam.

[9] Flanagan (1999) *Lessons for UK Foresight from Around the World for the Construction Associate Programme*. Construction Research and Innovation Strategy Panel, London.

[10] Hampson, K. and Brandon, P. (2004) *Construction 2020: A Vision for Australia's Property and Construction Industry*. Cooperative Research Centre for Construction Innovation, Brisbane, Australia.

[11] CII (1999) *Vision 2020*. The University of Texas, Construction Industry Institute, Austin Texas, USA.

[12] CERF (2000) *The Future of the Design and Construction Industry*. Civil Engineering Research Foundation, Washington, USA.

[13] ECTP (2005) *Challenging and Changing Europe's Built Environment: A Vision for a Sustainable and Competitive Construction Sector by 2030*. European Construction Technology Platform, European Commission.

[14] Harty, C.F., Goodier, C.I., Soetanto, R., Austin, S.A., Dainty, A.R.J. and Price, A.D.F. (2006) The futures of construction: a critical review of construction futures studies. *Construction Management and Economics* (under review).

Venture capital financing of residential investments

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Financial capital is one of the necessary resources required for residential investments. Yet growing equity requirements increase the likelihood that developers face financial constraints, which may prevent them from undertaking positive net present value projects. This paper investigates "free market" solutions to the problem of financing residential investments. The low housing production of new houses in Sweden constitutes the starting point of this paper. We find that specially designed real estate venture funds that will provide private equity and mezzanine debt financing, may be an important step in the right direction in order to increase the supply of risk capital in Sweden. Such funds may attract more risk capital to the real estate development business in a competitive environment, thus giving both developers as well as external debt and equity investors an increased number of financing and investment alternatives. We argue that inefficiencies in land acquisition, the planning process and the rental market must be reduced as much as possible in order to attract large amount of risk capital at reasonable terms.

Keywords: Development finance, private equity, joint venture, mezzanine financing

1. The need for an increased flow of risk capital into residential construction business

The quest for the causes and possible solutions of the problems related to the Swedish housing market is manifested in the large number of reports written lately [1]. We argue that there is a shortage of risk capital earmarked for residential development projects in general, and in particular for development of more innovative niche housing products, and that it is necessary to overcome this shortage in order to increase the supply of "standard" or "mainstream", as well as more innovative housing units. In particular we discuss and analyze a few - from a Swedish residential development perspective - quite new and alternative financing sources, that above all might be complementary to the traditional residential development finance sources applied in Sweden. The quest for a larger inflow of risk capital in order to meet the housing demand has its roots in the 1992/1993 changes in the Swedish housing policy, which among other things resulted in a substantial reduction in the public sector funding of housing construction. The implication of this policy shift is that the burden of responsibility for the financing and the risk-taking of residential investments have shifted from the public sector to the private sector [2]. In other words, there is an increased demand for risk capital from non-public institutions and private persons. Besides that the remaining government construction support vehicles are of much less magnitude than before 1992/1993, they are typically tied to specific conditions that limit the number of eligible construction projects. Such conditions might in particular seriously limit the room for smaller innovative developers [3]. Thus it is important for developers to be able to raise 100 percent of the necessary capital from sources that are independent of any government support. Today commercial banks usually keep away from lending more than 75 percent of the estimated market value of the land, frequently less [4]. This large equity requirements imposed by the commercial banks has resulted in a situation in which above all smaller, but also medium sized developers, must postpone or even cancel construction projects that otherwise are expected to be profitable. Yet another change that might negatively affect the availability for small- and medium sized developers to raise debt from banks is the implementation of the new capital accord Basel II in 2007.

2. Improvements in risk capital provision, land acquisition, municipal planning, and rent regulation

We argue that is above all the interplay between reforms and improvements in risk capital provision, land acquisition, municipal planning, and rent regulation, that could increase the competitive situation in the residential construction sector, and in the end enhance the supply of both mainstream as well as more high-quality niche housing developments.

3. Outside private equity and mezzanine financing

A developer has basically two alternatives to raise the capital needed to fill the financing "gap" between the amount the commercial bank will provide and the amount of equity the developer is able and willing to invest: the first alternative is to raise outside equity capital; the second is to find a lender who is willing to grant some type of loan that carries a higher risk than the conventional construction loan. A joint venture partner may provide the first alternative, outside equity capital. Miles et al [5] defines a joint venture partner as "any individual or institution that provides the developer with equity funding during the development period in return for a share of development profits" (p. 48). Indeed, Lundström [2], Psilander [3] and Pitschke and Bone-Winkel [6] emphasize the important role private equity funds and venture capitalists should have in the future as providers of necessary risk capital in order to foster and maintain a dynamic real estate development market. The second alternative a developer has in order to finance the funding gap is to raise more debt, which though typically is subordinated to the conventional construction loan in terms of collateral rights and income generated from the project. There exists a financial innovation that can offer the lender both a stable cash flow in terms of interest and principal payments, and some kind of protection from declines in the value of the outstanding debt: mezzanine financing. In fact mezzanine debt is typically secured by some type of partnership interest, like ownership shares in the development entity, in case the developer defaults on the mezzanine loan. Moreover mezzanine lenders may require some type of "participation interest" or "equity kicker", like a share of the profits from the sale, and a share of the project's net operating income (if any) until the project is sold [6]. Thus Mezzanine financing is usually considered to be a hybrid of debt and equity financing. Finally, since mezzanine debt is inherently more risky than senior debt, such loans typically carry significant higher interest rates but also higher loan fees than conventional construction loans. For instance the required rate of return on mezzanine debt, although higher than conventional loan, usually is substantially lower than the required return on equity, which is the most expansive form of capital. Further, some developers may prefer to depend upon an additional lending relationship than to rely on equity partnerships. Yet another important positive to using mezzanine debt instead of raising more outside equity is that debt does not necessarily decrease or dilute the developer's position. Note also that a joint venture facing a funding gap may rely on a mezzanine lender in order to fill the gap. It is also a well-known fact that many real estate developers (and real estate investors in general) consider debt financing advantageous since debt can magnify the return on the developer's equity position through positive financial leverage or gearing. In particular secondary financing (e.g. mezzanine debt) may result in positive financial leverage as long as the marginal after-tax cost of borrowing is less than the after-tax return on the development project. Psilander [4] also points out that when debt can take the place of equity, thus limiting the equity demands of each project, in particular smaller developers will enhance their opportunity to engage in two or more projects simultaneously. This may not only increase the supply elasticity of new housing construction, but also increase a developer's ability to diversify its equity capital into a number of projects with different features, thus decreasing the portion of risk that can be "diversified away".

4. Conclusions

An important challenge for the real estate development industry and the public authorities is to encourage the private equity actors in the financial market to create pools of capital that are willing to finance residential construction projects with both private equity placements and mezzanine investments. This includes enhancing business opportunities as well as reducing some important risks by carrying through changes in land acquisition, municipal planning and rent regulation.

References

[1] Lind, H. (2003a). *Bostadsbygggandets hinderbana – en ESO-rapport om utvecklingen 1995-2001*. Ds 2003:6. (*The steeplechase course of housing construction*). [With an English summary]. ESO. Fritzes .

[2] Lundström, S. (2001). *Bostäder finansierade med riskkapital. (Housing financed with risk capital*). Division of Building and Real Estate Economics. Stockholm, KTH.

[3] Psilander, K. (2004). Niching in residential development. *Journal of Property Research* 21(2), 161-85.

[4] Psilander, K. (2006). Should a small developer be more efficient than large ones? Submitted to *Journal of Engineering, Construction And Architectural Management*.

[5] Miles, E.M., G. Berens and M. A. Weiss (2000). *Real estate development: principles and process*, 3rd ed . Urban Land Institute.

[6] Pitschke, C. and S. Bone-Winkel (2006) The impact of the New Basel Capital Accord on real estate developers. *Journal of Property Investment & Finance. 24(1) 7-26.*

Contracting capabilities in construction-related businesses

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The aim of this paper is to delineate the contract design capabilities in construction-related businesses. Our hypothesis is that contracting capabilities are a part of the legal astuteness of managerial teams which provides a source of competitive advantage. Contract design requires building a bridge between actors at all levels of organizations: from top management to the construction site. Legal astuteness implies that managers, engineers and lawyers develop a common language in order to convey knowledge in continuous dialogue. In our view the key aspects of dynamic contracting capabilities involve identifying the context, ability to organise the bidding process, the use of standard form contracts in appropriate cases, contract design, adjusting to new circumstances, and closing the relationship. The hypothesis was tested in one case which confirmed our assumptions in the parts applicable to the study.

Keywords: Contract capabilities, dynamic capabilities, conveying knowledge

1. Introduction

It is widely agreed that successful project execution requires a proper contractual foundation. This is particularly true of large, complex construction projects which invariably involve multi-disciplinary teams and are therefore uncertain in many aspects. Risk in construction contracting can seldom be eliminated entirely but with ingenuous and skilful contracting the predictability of the outcome is improved.

The objective of this paper is twofold. Firstly, the contract design capabilities in construction-related businesses are delineated. Secondly, how these capabilities or lack of them can effect in this specific case project. We seek to develop a framework for understanding contracting capabilities as potential contributors to the performance of a firm's contractual relationships, and derive implications for the roles of managers, engineers and lawyers in the development of such capabilities.

2. Corporate contracting capabilities

Gordon [1] defines contracting capability as ingenuity in arranging co-operative agreements by communicating in implicit and explicit ways. It represents the capacity to establish presence in an incipient bargaining flow, to forge with others the bonds of trust needed to make an initial agreement, and to exhibit creativity in designing the actual contract. In a multiple time period, contracting capability also encompasses the ability to sustain co-operation by making sequential adjustments to the initial agreement and to win a reputation as a reliable contractor. It represents a valuable intangible asset, built up by long-term investment, that is important in determining future business possibilities and thus deters opportunism.

2.1 Contracting context

Context plays an important role in contracting. In this case it is the construction context that provides the background against which contracting capabilities have to be reviewed. In our approach we stress the importance of preventing risks. This requires first of all recognizing the risks and understanding their significance and implications to the project. One of the critical elements in a construction contract is the terms of contract dealing with the legal aspects of construction work while the engineering documents such as plans and specifications take care of the technical side of the project. The engineering documents are nevertheless equally important with the so called legal terms and are an inherent part of the contract. Two preconditions are considered necessary for the successful, appropriate allocation of construction risks: the atmosphere of trust between the contracting parties and a clear, mutual appreciation of all relevant construction risks and their effects.

2.2 Contracting capabilities

Contracting capabilities have been studied, among others, by Argyres, Mayer and Weber. Contract design capabilities are related to the content of the contract and, according to Argyres and Mayer, can develop. Argyres and Mayer categorized these capabilities into five dimensions. [2][3][4] This categorization adds value by helping isolate who should be most heavily involved in different aspects of contract design. Weber and Mayer pointed out that one key aspect is the ability to assess when to use standard terms versus designing a contract from scratch, which terms to include, and who should negotiate the terms. The list of dimensions is augmented by this observation as the 6th dimension summarised in Figure 1 below. In our opinion these dimensions are applicable irrespective of the contract type.

CONTEXT OF CONTRACTING

Dimensions of Contracting Capabilities

- negotiation and bargaining capabilities
- capability to sustain co-operation
- capabilities related to the content of the contract:
    - assignment of roles and responsibilities to the parties
    - allocation of control and decision rights to the parties
    - dispute resolution
    - contingency planning
    - communication process
    - use of standard form contracts
- capability to end the relationship

Figure 1. Contracting capabilities

We find that Gordon's definition complemented with Argyres, Mayer, and Weber's work serves well for our purposes and understanding of contracting capabilities for the present purposes. However, our aim is to enhance and specify our views through the empirical research in process.

3. Data and methods

For obtaining a holistic picture of contracting capabilities, it was deemed appropriate to use both primary and secondary sources. We collected data by careful studying of the written documents gathered from the company itself and the different contracting phases. This review was then complemented by interviewing the key actors in the construction project we studied.

We found that from the client's point of view some of the problem areas in contracting at first were a) top down model of management, b) high context dependence, c) turnkey contract type did not provide sufficient formalization for making the essential elements of the contract predictable, d) not enough knowledge was exchanged between the different levels of the company involved in the construction project, the team was too small and expertise was lost in key professionals leaving the company. The company however learned from this process and even if a number of the experts continue as part of the team, some of the positions where reshuffled, new professionals employed and a new contracting process is under way under new management. The new management has shown dynamic inventiveness which is one of the elements of contracting capabilities and legal astuteness.

4. Conclusions

In the studied case, the first contract phase showed insufficient contracting capabilities and thus lacking in legal astuteness. Legally astute managements have the ability to identify and pursue opportunities to use the law and the legal system to increase both the total value created and the share of that value captured by the firm [4]. Rather than viewing the law purely as a constraint something to comply with and react to, legally astute managerial team adopts an active role in managing the legal dimensions of business. The new project management has introduced reforms which are challenging as to competence and work load. Our research will later on focus on analyzing this new model of contracting and organizing the work. We will monitor how the contracting capabilities develop with the new model. The new model enables learning because experience can be disseminated from one to another of the many individual contracts. Our findings support Mayer and Argyres's [2][3] research conclusions that engineers and managers have a lot of substance knowledge relevant to contract design and that should be taken into account especially in complex, long-term contracts.

References

[1] Gordon B. (1995) *Communication and Contracting: A Link Between Business and Social History.* Business and Economic History, Volume twenty-four, no. 1, 288.

[2] Mayer K J. and Argyres N. (2004) Le*arning to contract: Evidence from the Personal Computer Industry,* 26-27.

[3] Argyres N. and Mayer K J. (2004) *Contract Design Capabilities and Contract Performance by high Technology Firms: Implications for the Roles of Lawyers, Managers and Engineers,* 14.

[4] Bagley, Constance E. (2005) *Winning Legally: How Legally Astute Management teams Can Use Law to Create and Capture Value.* Working paper; Harvard Business School, July 19, 2005

Ideologies, norms and prejudices underpinning environmental argumentation

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Environmental commitment has become a powerful discursive means of mobilizing actors and developing distinct organizational identity. However, the prevalent uncertainty in society today concerning the interpretation and operationalization of environmental issues opens up for conflicts of ideologies and interests within an organization, which may have serious implications for decision-making processes. Based on a comparative case study of three Swedish municipal housing companies, this paper critically explores how environmental issues are represented and given meaning.

Key words: Community of practice and action, Environmental issues, Green building, Sensemaking

1. Green ideas in the building sector

Although environmental issues have been on the agendas of governments, businesses and scientists for at least three decades, there still remain conceptual difficulties concerning what 'green' or 'environment' actually encompass. The concepts are in constant flux, shifting as actors who represent different social relevant groups struggle to find support for their specific interests. Thus, the natural environment is a contested terrain characterized by interpretative flexibility [1]. Depending on the context and the politico-ideological stance of the actors, environmental issues can be framed and take on different meanings in the heteroglossic arena of environmental contentions. In a study of Swedish building trade magazines' conveyed image of green building, it was found that uncritical and biased information was mediated to the practitioners, which suggested that the trade magazines failed to provide their readers with a diversified image of green building [2]. The trade magazines reinforced established and dominant views of green building within the building sector. As a consequence of the bias towards technical measures and the lack of long-term and creative problem definitions regarding environmental impacts, practitioners may be locked into a technocratic logic. In extension, if trade magazines are decision-makers' main source of professional environmental knowledge, decisions will be grounded on biased information, which may have serious negative long-term implications for the natural environment. This paper explores how environmental issues are represented and given meaning, that is, how they are framed and acted upon by individuals and organizations in the Swedish building sector. The emphasis is on the ways in which 'green ideas' are constructed in the different discourses of various organizational members, and how divergent representations may influence strategic green decision-making in the companies. Actors in the building sector seem to predominantly read trade magazines as their main source of professional environmental knowledge. Thus, attention will be paid to the link between building trade magazines' conveyed image of green building and the organizational members' representations of environmental issues in their professional context.

2. Managing environmental issues inside the housing companies

In the housing companies' management of environmental issues, three relevant groups stood out: *Environmental Key Actor(s)* (also referred to as the *Communities of Practice (CoP)* [3]), the *Environmental Unit*, and the *Business Management* [4]. In common for the two former groups was their lack of formal decision-making authority. Instead, all the business-strategic decisions, including environmental issues were made by the Business Management.In two companies, Alpha and Beta, two or three Environmental Unit members also sat in the Business Management. Because of their double roles, these influential actors had the possibility of controlling and acting on the strategic green decisions. They represented, what is referred to as the *Community of Action (CoA)* [5]. Notably, none of the environmental key actors were members of the Business Management, and the physical links between environmental key actors and the Business Management were limited.

2.1 Making sense of environmental issues

The study shows that among all green ideas that prevail in today's society, the housing companies made selective choices and only made sense of [6] ideas that fit their specific interests and context. Each company had developed their own distinct environmental profiles by appropriating some environmental areas as their key concerns; *hazardous substances* at Alpha, *waste management* at Beta, and *indoor climate* and *gardening* at Gamma. These environmental key concern(s) could often be traced to the key actors' specific areas of responsibility. By linking the historical development of green building on a national level to current actions and interpretations on an organizational level [4], the links between the companies' environmental areas of key concerns and the different environmental issues that had been prominent, e,g., in trade media [2], during the development of the Swedish green building discourse, may be highlighted.

2.2 Environmental issues as represented by CoA and CoP

Distilling the representations of environmental issues to two groups, i.e., the *CoA* and the *CoP* gives a different picture than did the entire list of representations. In common for both groups was a frequent use of abstract terms, e.g., sustainable development, and living environment. More, few mentioned the environmental key concerns of the companies. Instead, when giving their interpretations of 'green,' the CoP members, for example, related to what they considered to be the *necessary conditions* in the management of environmental issues, e.g., having the knowledge, motives and arguments in order to get the adequate resources. Thus, consciously or not, the CoP members seem to have argued for their own 'raison d'être' in the companies.

3. Discussion and conclusions

As shown by the divergent representations of 'green,' no closure has yet been reached regarding a common view of environmental issues. Contesting views risk mobilizing counter-action or non-action, which may be destructive for the companies' strategic environmental work. On the contrary, interpretative flexibility may also have positive effects, functioning as a driver for change and development.

Those who made strategic green decisions in the housing companies were not the same people as those who possessed environmental expertise. A consequence of having different *communities of practice* and of *action* is that contradictions between talk and action in terms of environmental issues may, and will, arise. The CoA members often represented financial, marketing, and technical interests – something that found expression in their representations of 'green' (e.g., problems and costs). On the contrary, the CoP members represented different environmental interests – and accordingly they argued for the need of their expertise in the companies. Thus, the two communities represent two disparate discourses, where the CoA was guided by short-term prerogatives (e.g., financial results) and the CoP was guided by more long-term prerogatives. Although the CoA members represented environmental interests in the Business Management, environmental issues were neither the main issue nor the expertise of these actors. Drawing on Gluch and Stenberg [2], if practitioners frequently use easily accessible environmental information channels, such as trade magazines as their main information channel, this may have implications for the decisions made by the Business Management. Although the environmental key actor(s) provide the Business Management with decision-making information, it is still a risk that Business Management members are influenced by the unreflective and biased picture given by the Swedish building trade magazines, or by their own agendas or organizational productivity, when they make environmental decisions. Accordingly, for environmental issues to be enacted at all levels of an organization, the environmental key actor(s) would also need to be empowered with decision-making mandates. A concrete suggestion might be to admit the environmental key actor(s) into the Business Management which would add to an aggregated knowledge in how to act upon environmental issues.

References

[1] Bijker W.E. (1995) *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. Cambridge, Massachusetts: The MIT Press.

[2] Gluch P. and Stenberg A.-C. (2006) How do Trade Media Influence Green Building Practice? *Building Research and Information*. 34(2):104-117.

[3] Brown J.S. and Duguid P. (1991) Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning and Knowledge. *Organizational Science*. 2:58-82.

[4] Stenberg A.-C. and Räisänen C. (2006) The Interpretative Flexibility of "Green" in the Building Sector: Diachronic and Synchronic Perspectives. *International Studies of Management & Organization*. Summer 36(2):32-54.

[5] Stenberg A.-C. (2006) *The Social Construction of Green Building: Diachronic and Synchronic Perspectives*. Disseration, Building Economics and Management, Chalmers University of Technology: Göteborg.

[6] Weick K.E. (1995) *Sensemaking in Organizations*. Sage: Thousand Oaks, CA.

The role of the architect- interpreter of the clients and users' needs

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The architect could be the actor responsible for the communication and interpretation of the users' needs, if the role is given. The education and the competence of the architect involved and above all the attitude towards the task, can be important for the result of the communication. What are the expectations on the role of being the interpreter of the clients' and users' needs and what could be the ideal role of the architect in the process? Is there a need of new competences and actors to understand the users' requirements?

Keywords: user's requirements, the role of the architect, design process, full scale modelling

1. Introduction

The building process confers on all the actors' involved great economic and technical responsibilities. To achieve good results via such professional teamwork, those involved must communicate with users so as better to understand the requirements. User requirements and demands must be understood by all, and in cultivating such understanding the architect can assume the roles of both the interpreter and guide.

2. Background

The cultural clash between the chaotic and complex design process and the restrained culture of management can give rise to both opportunities and obstacles. Architectural education that fosters appropriate skills helps create architects able to handle the role to manage the process and guide the user. An ideal situation is to have the ability to combine these working methods into the process; ideally, however, the architect should combine both approaches in the building process. Combining usability, aesthetics and long-term economic feasibility can certainly be a challenge for the architect, and attitudes to this challenge are often formed early on in architectural education.

3. The aim of my paper

Given my background as an architect, the research and case study in my licentiate thesis [1], allowed me to reflect on the roles and skills of all actors involved in the building process. Involving users in this process requires the ability to support dialogue and communication. Swedish architectural education seems to provide students with several tools with which to express and communicate their own ideas, but fewer tools for supporting dialogue with the users.

4. Method

Architectural programmes are offered at the University of Stockholm, at Chalmers University in Gothenburg and Lund University. The official descriptions of these education programmes reveal quite different formulations of their future role as an architect. A survey of third-year students at Lund University gave some ideas to their own perspectives on the future roles and abilities.

5. Theory

In 1996 the Swedish government asked the Byggkostnadsdelegationen [2] to consider how to decrease production and management costs in the building process. The universities are advised to develop their curricula especially to incorporate better knowledge of economics and how to handle communication and information flow within the organisation of a building project.

In her dissertation, Kristina Grange [3] describes the relationship between architects and other parties in the Swedish building market. Grange believes that architects in general have a pronounced desire for a stronger role; however, the rather conspicuous fact is that the architect is more or less invisible in the wider context of the building industry.
Birgitta Ericson and Britt- Marie Johansson [4] argue that there seems to be a certain degree of conservatism within the building sector and describes the conditions in the architectural firms as extending from team work to lone individual efforts.
Björn Linn [5] describes the design of built human environment as a very complex structure of problems. The role of architectural is to manage both good aesthetics and functionality connected with user requirements.
It is well recognised that the design quality of our built environment needs to be improved. According to

Stephen Emmitt [6] if creative design is to flourish, architectural management techniques and tools must be effectively applied. Design-orientated professionals must be better equipped to operate in shifting markets; they must have better business skills and better communication ability.
Dik Spekking [7] describes Performance based design of buildings PBD as a design based process on set of dedicated performance requirements. It is a process in which performance requirements are translated and integrated into a building process.

6. The role of the architect

General description of the architects working situation:
KTH: "KTH school of Architecture offers a programme integrating art, technology and social science. [8]
CHALMERS: ". Architects must be able to oversee and respond to technical, economic, legal, social and aesthetic aspects, and they must be able to work together with others." [9]
LTH: " the architect must have knowledge in many different areas, and be able to understand the relationship between Man and the built environment." [10]

Questions to third-year architecture students in Lund:

1. the role of the architect in the future, how they envisioned co-operation and what they wanted to achieve in their working role:- establish a trustful situation to the other actors and the possibility to be a part of the whole process. They want to be good architects, but not in an idealistic way.

2. *what changes they thought needed in the architectural education:*- broaden the education to allow higher overall level of attainment.

7. Conclusions

Education and knowledge as well as ability to cooperate and communicate seem to be important for a positive work outcome. Different methods can be used to match demand and supply. Official descriptions of Swedish architectural curricula at three universities in Stockholm, Gothenburg and Lund indicate that they deal with giving tools with which to express their aesthetic ideas.

8. Discussion

The architects' role as the interpreter of client and user needs ideally allows for life-long learning. Some of the architecture students at Lund University are eager to help create a better society and built environment. By co-operating with the other involved actors they also want to be a part of the whole building process. The tools and knowledge needed if architects are to act as guides and interpreters for the users and clients do not seem to be provided in their education. Students' desires to help design a better built world are easy to sympathise with. Their education can support these desires by supplying the communicative and co-operative tools to help architects perform their changeable creative role. Performing his or hers pedagog-ical and interpretative role can be a future challenge for the architect.

References

[1] Svetoft I. (2005) *Brukarnas krav I byggprocessen –en fallstudie,* Lunds tekniska högkola Lund, KFS AB.
[2] Från byggsekt till Byggsektor (2000:44)*Byggkostnadsdelegationens betänkande bilaga 2 – byggprocessen.* Fritzes Stockholm.
[3] Grange K. (2005). *Arkitekterna i byggbranschen-om vikten att upprätta ett kollektivt förtroende.* Chalmers Göteborg.
[4] Ericson B och Johansson B-M. (1994). *Bostadsbyggandet i idé och praktik.* Lund University press Lund.
[5] Linn B. (T10:1998). *Arkitektur som kunskap.* Byggforskningsrådet, Stockholm.
[6] Emmitt S. (1999) *Architectural Management in Practice.* Longman Essex.
[7] Spekking D. (2005). *Peformance based design of buildings.* PeBBu Domain 3 Final report. CIBdf Netherlands.
[8] Internet www.kth.se (10.06.2005)
[9] Internet www.chalmers (10.06.2005)
[10] Internet www.lth.se (10.06.2005)

Location-based management system for construction: principles and underlying logics

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Production efficiency has been elusive in the construction industry and it has been difficult to implement the new production methodologies which have been so successful in manufacturing industry. This paper argues that this is because of the emphasis on activity-based planning systems and poorly integrated documentation and cost systems which do not have production efficiency as their focus.
An new methodology is proposed based on the Location as the unit of analysis and the Task as the unit of control. The paper presents the planning components of this methodology, which is part of the location-based management system (LBMS). The basic structure is introduced and a method provided for integrating linear scheduling techniques with CPM methods using Layered Logic.

Keywords: Flowline, Scheduling, Location-based Management, CPM, Layered logic.

1. Rethinking the way we plan and manage construction

It is time to rethink the way we plan, manage and control construction.

The construction industry has developed a suite of ad-hoc systems which either cannot integrate. The basic mechanisms by which we develop our cost models, measure our buildings and schedule our work, provide little help to manage the issues which are at the forefront of industry concerns these days - efficiency, speed and productivity.

This paper proposes an alternative methodology based on a shift in the unit of measurement and the method of control. The unit of measurement should be the location. The method of control should be the work flowing through locations. Combined, these form a location-based methodology from which arises the Location-Based Management System. The focus is on improving the production system.

2. Location-Based management

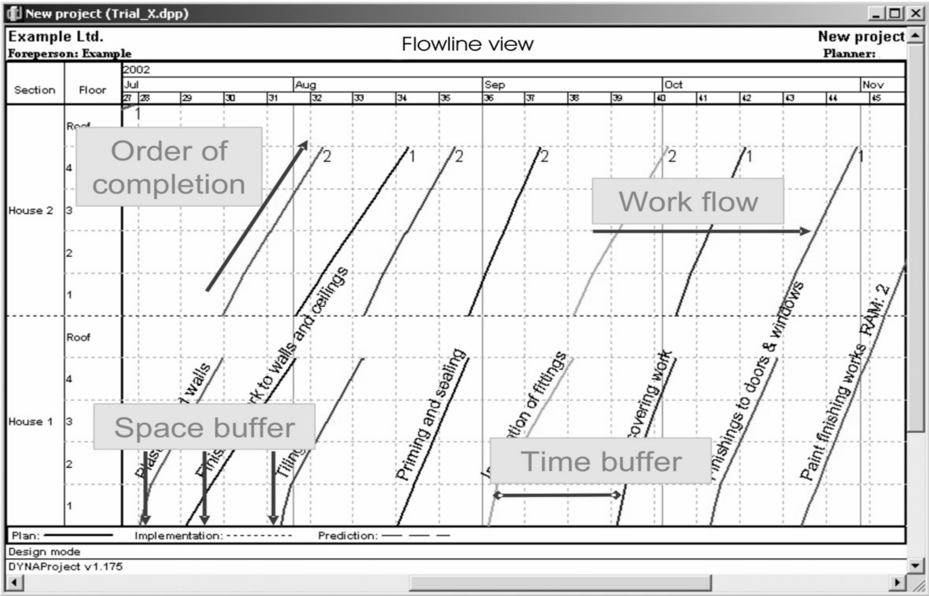
The location-based management system (LBMS) is planned to be an integrated system of management system components from design through to completion. Unlike previous systems, it is not focused on documentation exchange, although that is important, it is focused on data modeling to support production efficiency.

At the heart of location-based management is the location as the unit of analysis. Concentrating on the location for data modeling allows work continuity to be planned for tasks. Tasks consist of the related work packages which flow through the locations sequentially.

In the LBMS, locations in a project are defined by a Location Breakdown Structure (LBS). It is possible for the project to be broken down in many different ways, however, locations must be hierarchical so that a higher level location logically includes all the lower level locations.

Properties may be added to the BOQ items, such as standard production rates, cost data, (and anything that can be described in IFCs). The LBS provides the structure and the Location provides the container for all project data.

The Task is the method of control in the LBMS planning system.The location-based planning system differentiates between activities and tasks, where the definition of a task is that it contains work or activities which can be done by a single crew, or split among multiple crews. Location-based planning then uses CPM external logic to define the logic or connection between different activities within locations wherever they occur. However, unlike CPM, the planning system also considers a task's own internal logic, by allowing the planner to plan the location sequence and production rate to achieve continuous production. Thus CPM-logic applies between tasks within locations and flow-logic applies within tasks between locations. A location-based task contains multiple CPM activities, which correspond with physical locations.



Interpreting a flowline chart

Emphasis on the task enables a focus on production efficiency, as it is recognised that performance in a given location is not discrete and is highly likely to effect activities later in the task. If the crews are slow, they are likely to continue so. Furthermore, efficient use of resources requires that concentration is placed on minimising waste. This means reducing non-productive activities such as delays, waiting, mobilisation and demobilisation, double handling, stockpiling, moving and rework and defects. This is achieved by maximising the flow properties of the work (a Lean concept) and this in turn requires the task to be the unit of control, where contionuity can be planned and preserved through control.

Properties may be added to the Task, such as resources, learning attributes, risks, actual progress, etc.

A task should default to continuous production in order to maximise productivity.

The new theory of location-based scheduling involves far more than linking like activities in chains to derive resource optimisation. Rather, it involves several layers of interactive CPM logic which combine to form a powerful location-based logic, Layered Logic.

CPM is a tried and tested method for calculating schedules based on durations and precedence relationships.

Standard CPM has a single layer of logic, as it treats all activities independently and is unaware of location. This is an overly simplistic model for construction, as the assumption of independence through locations does not hold true. A more powerful set of logical layers is required to correctly model the typical construction process.

There are five logical relationships that arise when tasks are the unit of control rather than activities. These are:

1) External logical relationships between activities within locations
2) External higher-level logical relationships between activities driven by different levels of accuracy
3) Internal logic between activities within tasks
4) Phased hybrid logic between tasks in related locations
5) Standard CPM links between any tasks and different locations

This is a new system which will challenge our thinking about the planning, scheduling and control of construction work.

The social and cultural construction of risk

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Throughout the history of risk management three criteria have always been important to risk/project managers; they are cost, time and quality. However, the proven records in different industries show that time over-run, cost over-run and poor quality have always been the case. Furthermore, focusing on one of these three factors means sacrificing the others to some extent. Research shows that one of the most important influential factors on effective risk management is people who operate risk management tools and techniques and judge their results. It is also important to realise how people perceptions of risks are shaped and what the influential factors are. Hence, this paper seeks to identify the influential factors on risk perception based on pure literature review. The methodology that is utilised for the purpose of the study is to look at risk from two different angles; risk management literature and social-psychology literature.

Keywords: attitudes, perception, culture

1. Aim of the current study

This paper is the first part of a two-part study focusing on risk perception between an Iranian and a Swedish tunnelling contractor. The first stage, the content of this paper, focuses on the way perceptions of risk are shaped and discusses the influential factors on risk perception based on a comprehensive literature survey. In order to satisfy the aim of the first part of the study literature survey is carried out not only in risk management literature but also in social-psychology literature.
The objective of the first part of the study is to: 1) understand the underlying factors in risk management process, 2) understand what is meant by attitude and perception, 3) explore and compare different risk perception paradigms, 4) understand how cultural differences affect on risk perception and 5) highlight the influential factors on risk perception based on the chosen paradigm.

2. The underlying factors in risk management process

Looking at risk management process in different industries such as oil and gas, defence, insurance and aviation shows that they all follow more or less the same process in order to properly manage risk and communicate risk information. Research show that there are not much differences in the way different industries deal with risk, the tools and techniques they use and conclusions they draw. What makes difference in other industries compared to the construction industry is the way they manage 'the people side' of risk management. It is beyond the scope of this paper to look at different risk management tools and techniques. What is brought to attention in the current paper is an overview over 'a systematic risk management process', which consists of risk perception, risk identification, risk quantification, risk registration, risk prioritisation, risk analyses, risk allocation, risk feedback, risk revise and communication.

3. Attitude and perception

For the purpose of this study attitude is defined as [1:p28]: 'it [attitude] represents our major equipment for dealing with reality, reflects our style of operation, our way of coping with and dealing with problems. If we know something about an individual's social attitudes, then not only do we have a brief summary of what has gone before in the individual's experience that may affect his behaviour, but we may also be able to say something useful about his aspirations, his motivations, his striving towards his goals and to know something about why, along the way, he deals as he does with a great variety of social objects and values'.

4. Risk perception paradigms

Risk can be looked at either objectively or subjectively. The objective approach indicates that risks exist 'out there' and can be calculated mathematically. In this approach risk is simply defined as a product of probability and consequences. Subjectively is neglected in this approach. This approach is mainly in central attention of psychometric researchers.

Two risk perception paradigms are mentioned: psychometric paradigm and the Cultural Theory. For the purpose of this paper the Cultural Theory is used which fits more to the aims of the study.

4.1 Cultural theory

Cultural Theory indicates that the way people perceive risk is influenced by social and cultural structure of the society they belong to. Based on Cultural Theory each society has its own risk portfolios. It further indicates that the different risk perceptions can be explained in terms of four distinct world views known as cultural biases. They are hierarchy, egalitarianism, individualism and fatalism.

Renn [2] puts the cultural biases into risk taking behaviours context and relates individualists to entrepreneurs, egalitarians to egalitarians, hierarchists to bureaucrats and fatalists to atomized individuals.

5. National cultural differences

Jasanoff [3:p392] indicates that 'cultural differences penetrate so deeply into risk assessment that it is difficult to isolate any phase of the assessment process as purely scientific or truly universal'.

An extensive research carried out by Hofstede [4] over fifty different nations describes culture as the collective programming of the mind that distinguishes the members of one category of people from another. He then compares fifty different nations with each other and proposes 'the national cultural dimensions'. They are power distance, uncertainty avoidance, individualism and masculinity.

6. The influential factors on risk perception

Based on the extensive literature surveys on two different fields; namely risk management and social-psychology, different influential factors on risk perception are brought to attention. Some of the most important ones are as follows:

Confidence in dealing with risk, attitude of individuals, groups and organisation that try to manage risk, the level of relevant skills, knowledge and expertise in confronting an uncertain situation, the perception of probability or frequency of occurrence, the perception of impact magnitude, and memorable or imaginable events such as recent disaster.

Other factors are:

Trust between parties involved in risk management process, the effect of social networking, the level of job commitment, the level of employment, historical condition, power and authority in dealing with risk, number of people exposed to risk, ethnic background, gender and motivation to take risk studies into consideration.

7. Summary

This paper is the first of a two-part study; hence there is no conclusion at this stage but a summary. The centrality of people in risk management process is brought to attention. The underlying factors in a systematic risk management process are mentioned. Different risk perception paradigms are indicated and compared. It is concluded that the subjective approach toward understanding risk perception best fits to the aims of the study. The work of Hofstede in national cultural dimensions is believed to be influential on risk perception study, as perceptions of risks are determined by culture. Hence, they will vary systematically across different cultures.

The second part of the study will seek to identify 1) how does cultural difference affect on the ways contractors perceive risk? 2) how does cultural difference affect on the way contractors see the world around them and how does it affect on their risk taking behaviour? and 3) what are the influential factors on the way the Iranian tunnelling contractor perceive risk? What are the influential factors on the way the Swedish tunnelling contractor perceive risk?

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Reference

[1] Halloran, J.D. (1970). *Attitude Formation andChange*. Leicester, Leicester University Press,

[2] Renn, O. (1992). Concepts of Risk: Classification. In: *Social Theories of Risk*. (S. Krimsky and D. Golding, eds.). Chapter 3, Westport, Praeger.

[3] Jasanoff, S. (1987). Cultural Aspects of Risk Assessment in Britain and the United States. In: *The Social and Cultural Construction of Risk: Essays on Risk Selection and Perception*. (B.B. Johnson and V.T. Covello, eds.). Chapter 15 Dordrecht, D.Reidel Publishing Company.

[4] Hofstede, G. (2001). *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations*. 2nd. Thousand Oaks, Sage Publications.

Searching for the quality of the built environment

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The intention of this research is to explore the relation between the individual and real estate, and vice versa, with the aim that a future investor, economist, architect, urban designer, and financial expert would know what kind of surroundings a particular person (dis)likes, what does (or does not) he/she wish, what is his/her (dis)inclination, what kind of influence some real estate element has on the individual, all seen through the focus of working efficiency, the efficiency of the organization, social problems, health situation, and life style.

Keywords: value management, users impact.

1. The value concept

Real estate could be the object of interdisciplinary scientific research. In this research the relation of an individual with real estate was studied according to the technical, social, psychosocial, historical, cultural and economical influences. The real estate evaluation is placed in important relation with the perception of social climate and the manifestation of efficiency. Presented is the analysis of the relation between the real estate status of family and the social climate, self-evaluation of the family members, and values, different orientations, life style, identity and efficiency of the individual.

2. The perception of the built environment

The problem generally refers to the relationship between sociopsychological and real estate aspects. The interest was in: the structure of perceptions connected with different aspects of real estate in the living place and in its environment, the difference between the groups of participants regarding perception of environment and real estate aspects; and into the structure of perceptions, how the characteristics of real estates, connected with the work – place influence the feeling and conditions at work.

For the purpose of verification a research was carried out of different groups of participants with a wide set of different questionnaires, scales and differentials. Most of them were developed precisely for this research, and their instrumentation showed measurable characteristics. Results were analyzed according to statistical programs.

The research comprised four groups of participants:

- students of psychology from the Ljubljana University, Slovenia (n=25, mean age=25.80, SD=5.8, 0,9 women, 0,10 men);
- owners or employees of real estate agencies in Slovenia (n=31, mean age=43.55, SD=12.66, 0,4 women, 0,6 men);
- employees in the public sector and state institutions from Slovenia (n=24, mean age=39.20, SD=14.00, 0,6 women, 0,4 men);
- employees in the field of construction business in Maribor, Slovenia (n=28, mean age=37.36, SD=10.82, 0,6 women, 0,4 men).

The following variables were identified in the framework of the actual research:

- particular demographic characteristics;
- particular objective characteristics of living place and its environment;
- subjective variables, connected with living place and its environment. All evaluations were obtained as summative scores, using the semantic differential with seven point bipolar continuums.

3. Results and discussion

3.1 The difference between the groups of participants regarding perception of environment and real estate aspects

Evaluations of proper living place, of leisure time place have the lowest discrimination, and evaluation of the people, together with some evaluations of environment have the highest mentioned correlation.

The evaluation of the offers s closely connected with evaluation of people, what means that investors, social experts and designers should consider aspects, which facilitate the satisfying of social-emotional needs, while accessing the investments in environment's real estate.

3.2 The structure of perceptions connected with different aspects of real estate in the living place and in its environment

The results are centrally oriented, only some independent characteristics are oriented from outside, for example: cultural characteristics of a place, dynamic characteristic of a place, focus on everyday life and a group of three characteristics: the perception if the place is tranquil or noisy, peaceful or violent and if the people there are calm or exciting.

Dwelling problem and the lack of an efficient public transport system are one of the most serious problems in our country. Prices for the new apartments are very high, supporting the financial loan system is not attractive enough for young families, on the other hand there is not enough real estate for renting which causes very high rents. Conscious balancing of extreme trends and respect for multiple, not necessarily economical or natural conservation dimensions of sustainability, but also wider cultural ones in any physical scale, can help in establishing dynamic balance

3.3 The structure of perceptions connected with different characteristics of real estates, connected with the workplace

Three factors were extracted: 'functional accommodation', 'semiotics' and 'intelligence of the building'. The factor 'functional accommodation' correlates with the variables: age, material, transport, orientation, and floor. One of the major current impacts on urbanization is the economical influence [5], it could be said that 'urbanization means the transformation of society'. A successful design of urban systems has to take account of modern economical factors. ‘’The location of business is very important, taking account of the growing traffic and the trend of moving out and living in the outskirts of bigger cities [8], the flows of traffic and the access to parking places’’.

The factor, 'semiotics' correlates with the following variables: arrangement of rooms, accessibility, and colors of the rooms. ‘’The organization of rooms and also their correct arrangement is one of the fundamental steps of architectural designing. Organization of rooms takes account of the internal functional logic and its dependence on external spaces’’ [7]. The factor, 'intelligence of the building', correlates with coefficients with the variables: new technology and modern furniture.

4. Conclusions

The problem of this research was viewed on different levels, starting from the point that the real estate problems are inseparably connected with the problems with the physical and the social environment, law, infrastructure, health, urbanism, architecture and socio-psychological aspects, connected with different real estate characteristics.

The use value of designed urban capacities fairly depends on veneration of human preferences within the matter of urban, living or working place and in its environment. Therefore we can establish that such an analysis which is shown in the paper, suitably extended to all relevant questionnaire items, represents an important subjective input of basic programmed definitions in spatial disposition, building comprise, shape, type, purpose, and land use.

It becomes obvious that whenever we strike on the lack of objective performances, generally accepted as standards and guidelines in urban development process, we can always involve the subjective results of such an analysis. For the “use value” of residential build-up development is individually, regionally and chronologically dependent we see this checking process permanent.

References

[1] Baum, A. & Paulus, P. (1991). *Crowding*. V.D Stokols & I. Altman (ur.). *Handbook of environmental psychology*. Krieger Publishing company, Florida

[2] Berne, E. (1973). *Games people play*. Penguin, Harmondsworth .

[3] Davidson, N. (1999). *Urban grafts: a study of residual space in urban restructuring strategies*. Edinburgh: College of Art/Heriot-Watt University, MA Thesis .

[4] Dittmar, H. (1992). *The social psychology of material possessions (to have is to be).*: Harrester Wheatsheaf, New York.

[5] Goodall, B. (1978). *The economics of Urban Areas*. Pergamon press, Oxford.

[6] Korelc, N. (1999). *Ergonomija bivalnega prostora.* Fakulteta za arhitekturo, Ljubljana.

[7] Koželj, J. 1987. *Tipologija mestne stanovanjske arhitekture in njena sovisnost z morfologijo mestnega prostora.* Krt, Ljubljana.

[8] Pogačnik, A. (1986). *Prostorski vzorci naselij enodruzinskih his v Sloveniji in njih urbanisticno usmerjanje* . University of Ljubljana, Ljubljana.

[9] Polič, M. (2001). *The Environmental psychology*. University of Lubljana, Ljubljana.

[10] Ratcliff, R.U. (1949). *Urban land economics.* McGraw-Hill, New York.

[11] Rokeach, M. (1960). *Open and close mind.* Basic Books, New York.

Growth of micro enterprises- vital for the survival of the UK construction industry

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This paper explores the issue of growth in micro enterprises in the UK construction industry. The paper highlights the non-growth and high attrition phenomenon which is observed in micro enterprises in the UK construction industry and tries to shed light on two key issues namely the reasons why micro enterprises should grow and inhibitors of growth.

Keywords: Micro-enterprises, growth inhibitors, owner manager.

1. What is a micro enterprise and why are they important to the UK construction industry?

Micro enterprises are quantitatively defined as enterprises which employ fewer than 10 persons and whose annual turnover or annual balance sheet total does not exceed 2 million euro [1]. Micro enterprises are vitally important for the UK construction industry as they make up 98 percent of all construction enterprises in UK; 60 percent of all the employees in the UK construction industry work in micro enterprises and they also contribute to 40 percent of total turnover of the UK construction industry [2].

2. Why should micro enterprises look for growth?

Over a 10 year period, the rate at which the number of micro enterprises in the construction industry that joined the VAT system has not significantly changed. In 2004 there around 21,865 registrations in the UK and there were 18,445 de-registrations with respect to micro enterprises in the UK construction industry, this equates to an 84% attrition rate of businesses; the average survival rates of micro enterprises in the UK construction after three years of registration decreases to about 70.4 percent as against 91.4 percent after one year which is rather dismal [3]. Considering the position of micro enterprises in the construction industry, such a high failure rate and low survival rate would be disastrous for the whole UK construction industry, given that micro enterprises employ 60 percent of all employees in the construction industry. Micro enterprises are responsible for training and employment of majority of the novices who join the construction industry as micro enterprises have minimal entry barriers. Thus it would not be wrong to suggest that failure of micro enterprises would drastically affect the skill shortage which the UK construction industry is suffering from. In a scenario where strong real term growth of 15% is anticipated for construction output between 2005 and 2010 in the UK construction industry [4], the number of micro enterprises is not growing at the same rate. The UK construction industry finds itself in a rather grave situation as mature micro enterprises don’t grow and in case they do grow into small or medium sized firms there is no one to take their place; the situation is further exacerbated by decreasing number of entrants into the industry who could startup micro enterprises in the future.

3. What are the conditions for growth in a micro enterprise?

The conditions or pre-requisites which need to be in place for an enterprise to grow as suggested by Penrose [5] are as follows; 1) Prevailing Environment; 2) Skill Base of the Enterprise; and 3) Perceptions of the Entrepreneur.

Studies on the importance of external environment for growth in a micro-enterprise are limited in number and were found generally lacking in their effort to prove this point; there has a scope for further research in this field. Micro enterprises have no real control on the external environment; all they can do is to constantly observe the external environment for opportunities and threats and then act accordingly to take measures to counter the threats and make the best of the opportunities so as to gain a competitive advantage.

The ability of the entrepreneur to take advantage of what he sees in the environment is dependant on the types and amounts of productive services existing in the firm and what it is accustomed to operate [5], thus it would not be wrong to suggest that core competency of an enterprise has to do with the following: a) Productive services offered by the firm; and b) And what it is accustomed to do. Thus it would not be wrong to say that core competencies of an enterprise has to do with what services it specialises in and how adept it is at doing it. Micro-enterprises need to focus on enhancing their core competency in order to improve their ability to achieve growth. Core competencies are internal factors and hence micro-enterprises have complete control over them.

Micro enterprise growth as has been proposed does not represent a self-evident phenomenon nor is it a matter of chance, but is a result of clear, positively motivated business intentions and actions on part of the owner manager, driven by the belief that the owner manger can produce the desired outcomes [6].

4. Views of the owner managers and employees?

As part of the study conducted for this paper, face to face interviews were conducted with owner managers and employees of 60 micro enterprises employed within the UK construction industry so as to analyse their self perceived notions concerning the prerequisites for growth namely, the external environment, skill base and core competencies and their perceptions. Some important results of this exercise have been highlighted below:

For 38 percent of the owner managers who had started their own businesses, independence was the motivation to start up; this shows that very few owner managers started off with an entrepreneurial seizure.

69 percent of the young apprentices working in micro enterprises were not interested in starting any sort of business as working in the construction industry was merely a stop gap arrangement.

The majority of the owner managers had limited educational qualifications; only 10 percent had undergrad degrees. The interviewed owner managers were aware that, if they possessed better educational qualifications, they would have been able to manage their businesses better.

Most of the micro enterprise owner managers believed that micro enterprises are at the base end of the construction industry supply chain and not very important to the UK construction industry; this shows their lack of self belief to some extent.

They found the industry environment growth averse, nonetheless majority of the owner managers were satisfied with the current status of their businesses and were not looking to grow their businesses. This lack of desire to achieve growth in their businesses could stem from their lack of self belief and could also be traced back to their initial motivation for starting their business which was independence.

On being presented with the harrowing statistics concerning the high attrition rate of micro enterprises, majority of the owner managers were not worried as according to them if they found themselves in such a situation they would be no too worried as they could always find a job given the high skill shortage in the UK construction industry.

5. Conclusion

This study has attempted to look at the variable components which are integral for growth for a micro enterprise in the construction industry. This is a suggestive study and does not claim to have found the panacea for treating the high failure rate of micro enterprises instead has tried to address the issue and hints that there is definitely a way forward. It should be noted that growth of a micro enterprise is not within the complete volitional control of the owner manager instead, is defined to a great extent by the external environment. The main drivers of the construction industry should investigate this issue in greater depth and should encourage mature micro enterprises to grow thus creating a vibrant environment within the micro enterprise sector which would be conducive for new entrants.

References

[1] European Commission (2003). *The new micro enterprise definition: user guide and model declaration*, Enterprise and Industry Publications.

[2] DTI (2006) *Construction sector annual report 2004-2005*, http://www.dti.gov.uk; Accessed on 27/04/06.

[3] SBS (2005) *Business start-ups and closures: VAT registrations and de-registrations in 2004*, http://www.sbs.gov.uk/SBS_Gov_files/researchandstats/vatpn2004.pdf; Accessed on 11/05/06.

[4] MBD (2006) UK Construction Market Research Report, http://www.mbdltd.co.uk; Accessed on 28/03/06.

[5] Penrose, E. T. (1959) *The theory of the growth of the firm*, John Wiley & Son, New York, New York.

[6] Gray, C (1997). “Managing *entrepreneurial growth: a question of control?” small firms: entrepreneurship in the nineties*, Paul Chapman Publishing, 18-29.

Cultural change in construction partnering projects: the role of Leadership

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Since partnering is seen as changing behaviours and attitudes, cultural transformation cannot be forgotten in the process. Much of the literature tends to presume that cultural alignment is a prerequisite for partnering. This paper initially reviews the major cultural and behavioural challenges and their root causes in construction partnering projects. This research attempts to identify a substantial range of the elements through cultural web, which must be managed if a strategic and cultural change is to be successful. In this context, a model for the process of cultural change is proposed.

Keywords: Partnering, Cultural transformation, Cultural web, Leadership.

1. Concepts of partnering

In recent years there has been a growing interest in the use of partnering in construction. Partnering and the related forms of collaboration have been seen as a way of dealing with the fragmentation and lack of integration that have bedevilled attempts to improve project performance over the years [1]. Many commentators argue that partnering can have a substantial positive impact on project performance, not only with regard to time, cost and quality objectives, but also with regard to more general outcomes such as greater innovation and improved user satisfaction.

Furthermore, mutual trust and understanding of each others' commitments appears to be the prerequisites of changing traditional relationships to a shared culture in partnering [2]. Bresnen and Marshall [1] reinforce the requirement for the change in attitudinal and behavioural characteristics to achieve mutual trust. Barlow et al. [3] succinctly argues that, to achieve mutual trust, organisations must ensure that individual goals are not placed ahead of the team alliance. He also supports the idea of ''gain-sharing'' which effectively relates improvements back to all the participants. All these point out that, partnering is built upon the attitudinal and behavioural characteristics of participants which lead towards mutual trust to move away from traditional adversarial culture of construction industry.

2. Partnering challenges and problematic issues

The concept of partnering, overhauls the ethics of traditional contracting with the paradigm shift towards co-operative and caring environments. According to Naoum [2] successful partnering could attain win - win solution and gain sharing. In general, with a cultural shift in attitudes project partnering can be successful and bring benefits to the stakeholders involved in the project partnering process. However, changing traditional relationships to shared culture requires mutual trust and dedication to common goals. An absence of mutual trust and scepticism within participants may result in various problematic issues.

Much of the literature tends to presume that cultural alignment is a prerequisite for partnering. However, it is certainly not easy to bring about cultural change to adopt a new set of behaviours as a consistent way of working among the people. Atkinson [4] identified fear, perceived loss of control, difficulty in learning to do the things differently, uncertainty, addition in work and unwillingness to commit as the reasons for people to resist change. Conceptualisation of the relationship between partnering and culture [1], resistant to change from traditional, adversarial and exploitative ways, Lack of corporation based upon fundamental differences in interests between the parties to contract, profitability and uncertainty issues, unwillingness to commit fully to close, long term relationships together with the construction industry perception of mistrust can be considered as some of the reasons to resist cultural change towards collaborative relationships.

Successive independent reviews of construction have emphasised the need to improve the culture, attitude and working practices of the industry. It is very important to understand the construction organisations and their underlying assumptions to make these attitudinal and cultural improvements in the industry. However trying to understand culture is not straight forward. The day-to-day behaviours not only give clues about the 'taken-for-granted assumptions' but are also likely to reinforce these assumptions. The cultural web [5] is a useful tool to attain rich source of information about an organisation's culture.

3. Leadership of cultural change

The concept of the 'cultural web' is a representation of the taken-for-granted assumptions, or paradigms of an organisation and the behavioural manifestations of organisational culture [5]. It arose from the belief that understanding and characterising both the culture and subcultures within an organisation could help to predict how easy or difficult it would be to adopt new strategies. This concept defines organisational culture as layers of values beliefs and taken-for-granted assumptions.

A detailed map produced by the cultural web would expose a rich source of information about an organisational culture. This understanding of present taken-for-granted assumptions can be used to identify areas to be modernised and transformed to facilitate behavioural and cultural change in construction partnering projects. Comparison of cultural webs of 'parties to partnering contract' can also reveal the requirements to form cultural alignment between the parties. It is argued that cultural web not only helps to clarify main and subconscious cultural, structural and procedural characteristics of an organisation but also to show which values, believes and artefacts need to adapt to a new strategic direction and which ones should be maintained and strengthened. Also it represents a substantial range of the elements which must be managed if a strategic and cultural change is to be successful.

Together with the understanding of current state of culture, management has the most significant role to play in the transformation of attitudes. Two imperatives in the management of cultural change are the leadership's ability to think culturally and to conceptualise, via a working model, the change process. Johnson et al. [5] propose three prolonged approach to change management: that is a focus on power and politics of acceptance, management of symbolic processes and the concurrent management of organisational routines.

In order to effect change powerful support is required from an individual or group combining both power and interest. Johnson et al. [5] propose manipulation of organisational resources, relationship with powerful stakeholders and elites and activity with regard to subsystems in the organisation as the mechanisms to build a power base and to achieve commitment to a course of action. Furthermore, it is argued that changing symbols can help reshape beliefs and expectations because meaning becomes apparent in the day-to-day experience people have of organisations [5]. Changes in physical aspects of work environment, rituals, organisational structure, control mechanisms, stories and especially changes in the behaviours and language used by strategic leaders themselves are considered as powerful symbols of transformation. However, well established routines can be serious blockages to change. Routines are closely linked to the core values of the paradigm, so changing routines may have the effect of questioning and challenging deep rooted beliefs and assumptions of an organisation. This requires persistence and political acumen.

4. Conclusion

This cultural change mechanism seems very complicated in the context of partnering since the cultural alignment requires to be extended to the parties of partnering charter. It is certainly not easy to bring about cultural change to adopt a new set of behaviours as a consistent way of working among the people. Many commentators stress the importance of decentralised, flexible structures, where the team is expected to operate with considerable autonomy and discretion to convert formal partnering arrangements into real differences in behaviour at operational levels. They insist on top management support, commitment and enthusiasm in generating and sustaining changes in collaborative approaches. Cultural change is therefore a sensitive issue and it is very important to lead the whole process all the time.

References

[1] Bresnen M. and Marshall N. (2000) Partnering in construction: a critical review of issues, problems and dilemmas, *Construction Management Economics*, 18, 229-237.

[2] Naoum S. (2003) An overview into the concept of partnering, *International Journal of Project Management*, 21, 71-76.

[3] Barlow J. and Cohen M. (1997) *Towards positive partnering*, The Policy press.

[4] Atkinson P.E. (1990) *Creating cultural change: The key to successful Total Quality Management*, London, Pfeiffer.

[5] Johnson G. Scholes K. Whittington R. (2005) *Exploring Corporate Strategy*, 7th ed., England: Pearson Education Limited.

Plus ça change: an empirical evaluation of the 'appalto integrato' procedure

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In 1994, a new Italian law redesigned the rules according to which capital programs in the public sector are defined and funded, design proposals selected, and procurement processes organized. Central to the original spirit of the law was the clear separation of design and construction responsibilities as well as the organization of the design procurement process into sequential stages, each with its own explicit objectives and protocols. Just over ten years after the introduction of the legislation, and following three amendments to it, evaluations about its effectiveness and consistency differ. By using the recent development of the Athletes' Village for the Winter Olympics in Turin, the paper examines the theoretical strengths and actual shortcomings of the 'appalto integrato' – an increasingly common procurement procedure introduced by the law – highlighting its internal contradictions as well as its intrinsic flaws in design coordination and quality assurance.

Keywords: Italy, public works, building procurement, design process, design-and-build

1. The Legge Merloni

In 1994, the Minister of Public Works in the XI Legislature Francesco Merloni signed the first version of the law 109/94 for public works. The law, gone through three revisions and amendments since, was meant to trigger a process of reform inside a sector such as public works that relied, for its general lines, on a normative framework dating back to 1895. The most innovative aspects of the law were oriented towards ensuring quality, guaranteeing proper competition between enterprises, and towards respecting cost and time planning. Within this perspective, the Legge Merloni emphasized the centrality of design in the operations of the industry, attempted to clarify actors' roles, and worked to expand the technical role of public administration. Changes were brought about through a series of instruments, amongst which is the procedure of the *appalto integrato*, a form of design-and-build that many consider to go against the principles enunciated by the very same piece of legislation. The paper draws attention to this method in order to tease out its possible motivations, discuss its effectiveness, and capture the transformations of the law.

2. The 'appalto integrato'

The *appalto integrato* is an open procedure that assigns final construction design responsibilities in conjunction with the execution of works. 'For construction' documents are developed by the successful bidder on the basis of a final design provided by the administration. Initially, the law intended its application to be limited to works of archeological scope, or where a significant percentage of the contract value lay with mechanical systems. This way, the stated aim of the legislator was to improve the efficiency of the process, the constructability of the project, and its performance in use. More recently, with the extension of its applicability to a broader category of works, the practice of the *appalto integrato* has spread widely in the industry. Yet its increasing popularity raises questions about the safeguarding of the original intent of a law that had, in the separation between design and execution one of its pivotal points. To investigate this issue, a case-study was prepared that focused on the realization of the housing for the athletes competing in the 2006 Winter Olympics in Turin.

3. The Olympic Athletes' Village in Turin

The village for 2,500 athletes had a very compressed program from the start. With the brief released in July 2002, construction was scheduled to commence in June 2003 and to be completed by August 2005. The client chose to run a competition for the architectural design and to resort to *appalto integrato* for the procurement of construction documents and the compression of the schedule. Although site practical completion was awarded shortly before the Games started, this milestone was achieved six months after the date originally set. Moreover, since the construction documents phase reached completion eight months after the planned ground breaking date, the release of technical documentation for approval had to be organized in separate packages on a fast-track basis in order to regain time.

4. Design, building quality, and efficiency

Although the Olympic Village was handed over to the Agency for Torino 2006 in time for the Games, its procurement process was far from successful as far as the issues the Legge Merloni is supposed to tackle are concerned.

To start with, the project seems to have systematically lacked proper resolution of the design. Variations in briefing instructions also characterized it, and generated requirements often difficult to address that rendered previous solutions obsolete and modified spending thresholds. Additional work and rework were not minimized through the monitoring activity and tools imagined by the law. Overall, a lack of sufficient design coordination among the players could be detected at various scales. These concerned the links between architecture and technical designs but also the standards required for particular solutions. In this climate, the pressure of completing the work in time for the Games kept rising, ultimately forcing the adoption of fast-track documentation procedures that made overall design control difficult to ensure. Outsourcing construction documentation to external parties compounded the problem.

Today, the results of this process are before the public's eyes. The as-built project is very different from the initial proposal, even though the framework of the Legge Merloni is supposed to limit variations to the advantage of design resolution. Many of the residential typologies have been modified, ground floor circulation and layout are different, and environmental design strategies have either been lost in the process or have seen their implementation components radically altered. The turbulence of the design process has affected the level of constructed quality, which hardly suggests the progressive refinement imagined in the text of the reform.

In the end, the process was not efficient in terms of time or cost, neither for the client nor for the professionals involved; it created situations of conflict rather than collaboration; it did not help professional definition; and it was not instrumental to the injection of technical innovation into the design.

5. Lessons from Turin

The nature of the study conducted makes its findings relate closely to the project examined. In this case, the outcome recorded could be a function of the particular situation in place and the specific actors involved. Yet, the development of the Athletes' Village also enables one to express more general concerns about the industrial appropriateness of the *appalto integrato* as a procurement method, particularly in light of its alleged advantages over traditional contracting and the Legge Merloni's emphasis on the separation of design and construction. In fact, the data collected on the specific experience suggest the following:

There appears to be a dislocation between the conceptual skeleton of the law and the practice of design in construction. The Legge Merloni optimistically imagines a design progression internal to the building procurement process that may not be real, and sit awkwardly with the actors formally identified. The timeline of the Turin project, which reduced phase length as it moved forward, offers an indication of this possible 'fallacy'. The initial project planning document nominally assigned 90 days for preliminary design, 70 days for architectural design and 60 days for construction documents. In reality, the first took 90 days, but the second 134, and the third 150. One of the things that emerged is that decision-making and coordination became more (rather than less) collective and cumbersome as the project moved forward.

This could have very well been because of the uncertainties surrounding the post-Olympic use of the site, and the consequent modifications to the project *in fieri*, which delayed decisions and put pressure on the end of the process. If this was the case, then the conclusion would be that, *in appalto integrato*, absolute clarity of intent is needed from the outset.

Yet the reversal of design stages time could also indicate that, rather than reaping the advantages of design and construction integration, the *appalto integrato* can suffer from the separation forced onto the design process; not only because in construction it is difficult to stick to plans, but also because this separation ends up blurring roles, thus removing clear individual stakes from the project, allowing responsibility and blame to be passed on, and decreasing the incentive to perform well.

Moreover, the various strategic alliances and outsourcing networks formed for the Turin project could indeed be a symptom of a structural difficulty in the Italian building sector, where there may be too few subjects capable of operating autonomously, either in providing advanced design services or design and construction services together. If the successful adoption of *appalto integrato* can only take place through temporary associations of businesses, then strong vertical and horizontal coordination must be ensured in reality, above and beyond the current formal provisions of the law.

An integrated antecedental model of leadership development

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Researchers are convinced that certain trigger events and experiences in the lives of individuals stimulate the leadership schema which eventually results in the development of certain characteristics which are crucial for an organizational leader. These antecedents have not been explored in an integrated manner in studies on organizational leadership. The paper introduces 'Integrated Antecedental Model of Leadership Development' (IAMLeaD). The model considers the leadership development process in a holistic manner and caters for many of the gaps present in earlier studies. The model provides comprehensive taxonomies of significant individuals and experiences (antecedents of leadership) which develop characteristics in an individual who demonstrates leadership behavior at later stages. Potential applications of the model in organizational context are also suggested.

Keywords: IAMLeaD, Antecedents, Leadership, Development

1. Introduction

Despite widely researched, few people have been able to fully understand the concept of leadership. Researchers are convinced that that leadership is a vital component of project collaboration and project manager is one of the critical factors affecting project planning, scheduling and communication, particularly in large and international projects. Moreover, contemporary large and international projects pose unique challenges for organizational leaders and project manages which range from leading cross cultural teams and stakeholders to complex financial, environmental, legal, political, and social issues. Such situations demand for high quality leaders who can cope with these challenges. Despite its undeniable understanding and importance, leadership research in construction industry has made limited effort to understand the subject and genesis of leadership development [6] [19].

Some investigations [2] [5] which attempt to explore the leadership antecedents have either discussed few variables as predictors of leadership development or have focused on the prediction of a certain type of leadership behavior or style. Furthermore, most of the studies which correlate the leaders, leadership and leadership development with motives, triggers and antecedents have been conducted in the fields of political science and political psychology. There is scarcity of such studies on leadership in project and business organizations where leadership research mostly concentrates on skills, traits, attributes, styles, effectiveness, and performance of leaders but ignores the biological, psychological, and social histories of individuals which actually generate the leadership characteristics. Earlier research [29] also notices some flaws such as: (i) research examining the leadership development has been conducted without a clear theoretical framework; and (ii) from an experimental perspective, research in leadership development has usually been retrospective in nature and presents several questionable findings.

Briefly, research in mainstream leadership and particularly project leadership has yet to deal with a whole range of issues relating to leadership development such as socio-cultural and economic antecedents; biological, psychological, and physiological motivations; contribution of social institutions such as family, educational institutions, and business organizations; other leadership experiences, triggers, and episodes. In order to provide a larger and more comprehensive picture of such leadership precursors, this paper makes an attempt to integrate the whole range of possible leadership antecedents in form of a model.

2. Antecedental model of leadership development

The development of a comprehensive taxonomy of antecedents of leadership development is necessary to provide an understanding of the outcomes of leadership behaviors. For this purpose, this is essential to study various antecedents together using different techniques to capture the life history and antecedents of leaders in more effective and efficient manner. Therefore, to study leadership development in a holistic and integrated manner, the 'Integrated Antecedental Model of Leadership Development' or 'IAMLeaD' is presented here. This model primarily comprises three significant aspects of a leader's life. These aspects are: Significant Individuals, Significant Experiences, and Significant Characteristics.

Significant individuals are classified into four categories: (1) Biological Significant Individuals — those who are inherently present in a person's life without the person having any choice of them; (2) Accidental Significant Individuals — those whom the person comes across by chance; (3) Chosen Significant Individuals — those whom a person chooses to make significant in the person's life; and (4) Forced or Unnatural Significant Individuals — those who are forced to become a part of a person's life. Significant experiences are classified into: (1) Biological; (2) Physiological (3) Economic; (4) Psychological; (5) Socio-Cultural; (6) Educational; and (7) Occupational Experiences.

As discussed above, significant individuals and significant experiences together result in the development of significant characteristics in individuals. These are categorized here into five categories: (1) Self/Identity; (2) Values/Emotions; (3) Traits/Attributes; (4) Motivations; (5) Behaviors/Styles; (6) and Leader Quotients (social, emotional, spiritual, ethical, decision, communication, resilience, innovation, and contextual quotient).

Briefly, the life of a leader comprises various episodes in which significant individuals play their roles in different capacities. These episodes can have both positive and negative influences on the personality of a leader, or leader-self. Outcomes of these episodes eventually profile the actual leader-self. This leader-self characterizes the self-concept, self-knowledge, personal values and norms, personality, nature of social relationships, motives, leadership style, and various other dimensions which are attributed to leaders and leadership.

3. Summary and conclusions

In this paper, the 'Integrated Antecedental Model of Leadership Development' or 'IAMLeaD' has been introduced. This model takes account of all possible individuals and experiences which an individual may encounter or face in life. These individuals and experiences operate in concert to develop certain significant leadership characteristics in the individuals. Even a single significant individual or experience may have the capacity to transform an ordinary person into a leader but the totality of social context convinces the present authors that this is less likely to happen. Several factors come together and contribute to the development of a leader. Realization of these factors can enlighten the individual to improve and progress as a good leader in social and organizational settings.

IAMLeaD is applicable to track leadership development in all fields such as political leadership, religious leadership, business leadership, organizational leadership, and project leadership. It also suggests a general developmental perspective of humans as social beings. The model explains what factors lead to certain characteristics in leaders as members of a social setting. The model possesses the potential of wide application in leadership development and training programs in business and project organizations. Moreover, the model successfully explains the whole range of "leadership significants' and their genesis. Employers and human resource specialists can widely benefit from IAMLeaD to by analyzing 'leadership significants' to explore leadership potential and its course of development in their current and prospective employees. The model also helps to identify weak areas where the leader requires improvement and strong sides leader which can be exploited for leadership purposes. The model can also be useful in selection and promotion of project leaders with better significant characteristics. If the project leaders lack in certain qualities, the origins of such deficiencies can be effectively tracked through the model and training programs can be adequately designed to hone the required traits in organizational leaders and project managers.

References

[2] Avolio, B. J. and Gibbons, T. C. (1988) Developing transformational leaders: A life span approach. In J. A. Conger and R. N. Kanungo and Associates (Eds.), *Charismatic leadership: The elusive factor in organizational effectiveness*: pp 276-308. San Francisco, CA: Jossey Bass.

[5] Bennis, W. G. and Thomas, R. J. (2002) Crucibles of Leadership. *HBR at Large*, September Issue.

[6] Bommer, W. H., Rubin, R.S. and Baldwin, T. T. (2004) Setting the stage for effective leadership: Antecedents of transformational leadership behaviors. *The Leadership Quarterly*, Vol. 15: pp 195–210.

[19] Popper, M., Mayseless, O., and Castelnovo, O. (2000). Transformational leadership and attachment. *The Leadership Quarterly*, Vol. 11, pp 267-289.

[29] Zacharatos, A., Barling, J., and Kelloway, E. K. (2000) Development And Effects Of Transformational Leadership In Adolescents. *The Leadership Quarterly*, Vol. 11, pp 211-22

The impact of culture on leadership behavior: case of contracting personnel

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Cross-cultural leadership studies have generally emphasized a strong connection between culture and leadership styles, but, not many have focused on the construction industry. This paper proposes to determine leadership behaviors that are usually preferred and enacted in the Turkish Construction Industry. In the study, Hofstede's Values Survey Module (VSM) was used. A total of 723 respondents from 107 contracting firms evaluated their preferred and perceived leadership styles.

Keywords: culture, leadership, power distance, contracting personnel

1. Introduction

The intent in this paper is to examine leadership behaviors that are usually preferred and enacted in the Turkish Construction industry. The results presented in the paper are preliminary results of a major research project which has been carried out in collaboration with CIB TG-23 "Culture in Construction".

2. Culture and its implications for leadership

To what extent are leadership behaviors culturally determined? A good way to approach this question is to use Hofstede's model of 'national culture'. According to Hofstede, countries can be categorized along four prominenet value dimensions: (1) individualism-collectivism, (2) uncertainty avoidance, (3) power distance, and (4) masculinity. These four dimensions were validated by data from completely different sources [1].

Rodrigues [2] has described possible relationships among Hofstede's four dimensions and House and Mitchell's [3] four situation-linked leadership styles, namely directive, supportive, achievement, and participative.

On the other hand, a distinction appears across developed and developing countries in leadership practices. In a study investigating influence behavior of leaders in Turkey, Fikret-Pasa [4] found that Turkish managers and leaders show paternalistic attributes. Paternalism includes elements of both autocratic and nurturant behaviors where the leader acts like a father to the followers (Kabasakal & Bodur, 1998).

3. Leadership in construction

In considering leadership behavior in construction industry, the first thing that needs to be determined whether the construction industry is a special case. Firstly, the project-based nature of the construction industry will almost certainly have an influence on the managerial leadership behavior of professionals working in the industry.

In the context of the construction industry, the leadership behavior changes as the project progresses through its life cycle. During the different phases of the design process, leader behavior may need to allow for more debates, fine-tuning and deliberation. Yet, during the construction phases, it may be more structured and dominant.

Furthermore, the environment in which leadership is exercised is influential in shaping the leadership behavior. For example, the level of unemployment, strongly influences behavior adopted by the management. In this case, employees have less bargaining power due to high unemployment, and may have to accept whatever leadership behavior management adopts.

4. Research methodology

In order to measure the pattern and frequency of preferred and perceived leadership behaviors in Turkish contracting firms, a questionnaire was developed based on the work of Hofstede.

A total of 107 contracting firms were sampled in the study. The sample consisted of 723 respondents ranging from managerial to non-managerial professionals. In the study, respondents were asked to evaluate the behaviors of leaders whom they are familiar with as well as their preferred leadership behaviors (autocratic, paternalistic, consultative, participative).

5. Results and discussion

In order to determine whether respondents' positions had any influence on preferred and perceived leadership behaviors, respondents were divided into two groups reflecting the managerial positions (middle and first-level management) and professional but non-managerial positions (non-managerial professionals.

Results showed that the most preferred leadership behavior was participative (48.5%), followed by consultative (26.6%), paternalistic (19.0%), and autocratic (5.9%) type. This finding was inconsistent with Kabasakal and Bodur [5] who reported that the ideal leader in the Turkish society carries the behavioral characteristics of paternalistic and consultative leaders. The finding is also inconsistent with the contentions of others [6] that within the context of construction, authoritative leadership behavior is more frequently preferred than all other behaviors.

With regard to the perceived leadership behaviors of respondents, there are some differences between managerial and non-managerial positions. Results provided evidence that the most perceived leadership behaviors for managerial professionals were autocratic (24.4%) and paternalistic (24.0 %), followed by consultative (23.1%), and participative (17.9). For the non-managerial professionals, paternalistic was the most perceived leadership behavior (25.1%), followed by autocratic (24.6%), then consultative (19.1%), and then participative (8.8%) behavior. It is possible to explain this finding in light of the high power distance characterizing the Turkish Culture. Paternalism that was the most frequent perceived leadership behavior among respondents includes elements of both autocratic and nurturant behaviors where the leader acts like a father to the followers [5]. Furthermore, participative behavior was reported to be the least prevalent in the context of construction. This finding is consistent with the early observations of the Turkish Society. As a part of a large cross-cultural study, Kabasakal and Bodur [5] found that Turkish leaders are either predominantly autocratic / paternalistic, or consultative, but not democratic.

6. Conclusion

This study has examined the perceived and preferred leadership behaviors among contracting personnel within the Turkish construction industry. Effect of the position was also investigated.

In the study, it was found that the perceived leadership behaviors for managerial and non-managerial staff are predominantly autocratic and paternalistic. Participative leadership was reported to be the least prevalent within the industry. There appears to be an alignment between the most frequently observed leadership behavior of respondents and the high power distance characterizing the Turkish Society.

The study also found that there is a similar pattern for preferred type of leadership among the levels of positions examined. Responses show that participative leadership is more frequently preferred than all other behaviors.

References

[1] Hofstede,G., (2001) Culture' consequences: Comparing values, behaviours, institutions, and organizations across nations. 2nd edition, Sage Publications, London.

[2] Rodrigues, C.A. (1990) "The situation and national culture as contingencies for leadership behavior: two conceptual models", in Prasad. S.B(Eds), *Advances in International Comparative Management,* pp.51-68.

[3] House, R. J. & Mitchell, T. R. (1974) Path-goal theory of leadership. *Journal of Contemporary Business,* 3: 81-9

[4] Fikret-Pasha, S. (2000) Leadership influence in a high power distance and collectivist culture. *Leadership & Organization Development Journal*, MCB University Press, 2178, 414-426.

[5] Kabasakal H. and Bodur, M. (1998) Leadership, Values and Institutions: The case of Turkey. Research paper, Boğaziçi University, Istanbul.

[6] Lansley, P. (1994) Analysing Construction Organizations. *Construction Management and Economics,* 12, 337-34

Risk assessment and mitigation in transit projects

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The public transportation industry has a mixed history of success in delivering projects within budget and on schedule. Avoiding over budget and late projects whenever possible is highly desirable. Risk analysis is the systematic evaluation of uncertainty about the scope, cost, and duration of a project. This paper describes procedures for performing risk analysis, which consists of two parts: Risk assessment, the identification and evaluation of risks in terms of their likelihood of occurrence and their probable consequences, and Risk management, **,** *which consists of taking cost-effective actions to reduce risks and to realize opportunities. The approach described has been used by the authors successfully in major transit projects in the United States. The risk assessment and management is described in six distinct steps and the benefits of the process are discussed.*

Keywords: Risk assessment, uncertainty, cost, schedule.

1. Introduction

Public transportation projects have been wrought with cost and schedule overruns in the recent history. The public transportation agencies have been trying to avoid over budget and late projects whenever possible. A better understanding of what circumstances and events could lead to cost growth and schedule delays will help owners cope with these adverse conditions. Then, proper allowances can be made for problems likely to arise prior to or during construction. One such management practice is project risk analysis. Risk analysis is the systematic evaluation of uncertainty about the scope, cost, and duration of a project [1&2]. This uncertainty is in the form of risks that a project could encounter during the course of its development. It can also be in the form of unknown opportunities for improving the cost and schedule prospects for a project.

This paper describes procedures for performing risk analysis, which consists of two parts:
Risk assessment — the identification and evaluation of risks in terms of their likelihood of occurrence and their probable consequences, and
Risk management — taking cost-effective actions to reduce risks and to realize opportunities.

2. Risk analysis process

The risk assessment process can be implemented in six steps: (1) validation of project scope, base cost and base schedule, (2) identification and quantification of risks and opportunities that affect project budget and schedule, (3) modeling of risk factors, (4) review and discussion of model results, (5) development of risk mitigation plan (RMP), and (6) implementation and monitoring of the RMP. The first four steps are called risk assessment, while steps 5 and 6 are called risk management.

3. Risk assessment

Risk assessment starts with validation of project scope, budget, and schedule. It ideally should be conducted in early phases of design so that any problems can be dealt with. The validation involves reviewing project scope to ensure conformance with project objectives, and reviewing the cost and schedule (usually a CPM network) to identify areas of concern. This review should be performed in an objective manner and ideally should be performed by an independent agency. In this paper we are concentrating on cost risk analysis although the approach is equally applicable to schedule risk analysis as well. The project cost is divided into base cost (costs excluding contingencies and certain to occur) and risk cost (costs of unknowns that may impact the budget in either a positive or negative way). The risk costs will be calculated as a result of risk identification and quantification process.

Risk identification is best accomplished by an independent agency with the help of owner and the designer. A long list of every conceivable scope, cost, or schedule risk to a project are identified by studying project documents, interviewing design team, potential contractors, and material suppliers. These risks are then quantified in terms of both their likelihood of occurrence and their likely impacts. The list of risks are later screened and refined so that the risk analysis team's energy is focused on important risk factors. The final list comprises the project *Risk Register* which contains the list of all important risk factors along with their impact on project cost. The cost impact of many of the risk factors can only be estimated using a range or a random variable because of the uncertainty surrounding them. This means that quantifying their overall effect on project budget will require probabilistic modeling. Often, if the cost model is even moderately complex, an analytical solution is hard to achieve; in such cases the most common approach is to use Monte Carlo simulation.

In a Monte Carlo simulation, the modeler samples statistical distributions representing random variables (mainly cost in risk assessment) using a digital computer (mostly a personal computer). Each time the distributions are sampled, a total cost is calculated deterministically. By repeating the process of sampling the distributions and calculating the total cost a sufficient number of times (usually a few thousand times), a distribution for cost can be obtained. This distribution then provides all possible values for total project cost and identifies their probabilities. Several affordable software packages are available that allow Monte Carlo simulation using a spreadsheet. An important consideration when combining risk impacts to both project cost and duration is the potential for correlations among risk events, which can significantly affect the results. If correlations are ignored, then the spread of the outcome distribution is generally underestimated [3]. Several commercially available software packages allow correlation modeling.
Using the cost distribution, the analyst can establish a budget for the project in such a way that probability of sufficiency of funds remains above a desired threshold. This approach is commonly used to establish contingency budgets in probabilistic risk analysis. Review and discussion of the risk assessment results will allow the management to highlight problem areas and refine the analysis.

4. Risk management

The last two steps in risk analysis process consist of risk mitigation planning, followed by implementation, and monitoring. Risk management begins with screening of risks to identify which warrant mitigation. Risk management does not end until construction is complete (and probably should continue into initial revenue operations as well). To mitigate risks cost-effectively, they need to be prioritized. Risks can be prioritized with respect to project cost separately from project schedule or they can be prioritized based upon the combined cost and schedule impacts. The relative importance of individual risks to a project's cost and schedule, for example, can be determined by estimating how individual risk impacts change the total project cost and duration. Once risks have been prioritized (or ranked), the project owner must determine which high-cost and significant schedule delaying risks to a project it can influence. Two types are likely candidates for mitigation:

- Intolerable risks, such as events that could potentially stall a project or make it financially infeasible or unsafe, and
- High cost, high likelihood risks.

Several courses of action are available for addressing identified risks:

1. Eliminating the risk, for example through design changes or policy actions or by prohibiting the action causing the risk
2. Reducing the potential severity of the risk by similar actions
3. Transferring all or part of the risk to other parties, or
4. Accepting the risk, possibly without further action or perhaps with the purchase of insurance to offset the financial liability posed by the risk.

The project owner should document and monitor the implementation process, including the actual costs and consequences of instituted mitigations. A risk management plan pulls together information from the risk assessment and mitigation planning processes. It also identifies the owner's risk implementation and risk allocation strategies.

References

[1] Reilly, J., M. McBride, D. Sangrey, D. MacDonald, and J. Brown (2004) The Development of a New Cost-Risk Estimating Process for Transportation Infrastructure Projects. *Civil Engineering Practice,* Spring/Summer, 53-75.

[2] Parsons, Inc, A. Touran, and Golder Assoc. (2004) *Risk Assessment Methodologies and Procedures.* A white paper prepared for the Federal Transit Administration, U.S. Dept. of Transportation, May.

[3] Touran, A. and E. Wiser (1992) Monte Carlo Technique with Correlated Random Variables. *Journal of Construction Engineering and Management, ASCE,* 118(2), June, 258-272

New perspectives of planning in construction management with a special view to controlling

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Many methods of decision-making are well known, but it is to deplore that often decision-making in construction management is just based on experience and intuition. In such cases that methods are implicated, sometimes an overload of methods can be criticized. To improve this situation we suggest a controlling with a strategic and future view on structures and methods.
The 'Decision oriented controlling-approach' determines circumstances of decision-making, structures and methods to provide planning and decision-making procedures as subjects of the controlling. Controlling in this sense should enable the management to anticipate coming developments for taking influence on the developments. As essential instruments the 'Concept for planning decision-making procedures' and the 'Method to evaluate planning and decision making' are suggested.

Keywords: Planning, decision-making, controlling, coordination, organization

1. Introduction

Decision-making in construction management often bases on intuition and experiences as well. Of course intuition and experiences are very important. Recommendable methods to support planning processes should also find application in the practice of construction management. But often either a domination of intuition without application of methods or an overload with methods and information, i.e. electronic data-systems, as a burden to the staff members is to deplore [1], [2]. Considering these facts it is necessary to find a solution of this discrepancy between too much intuition and experience based decision-making on the one hand and the overload with methods and information on the other hand.

The improvement of systems and structures providing planning and decision-making, conside-ring the recognized difficulties, is the essential aim of the 'Decision oriented controlling-approach'.

2. Complexity in construction management

Construction projects are characterized by several aspects, that is why such projects are complicated. The practice of construction management has changed in many ways during the last decades. The larger con-struction firms as general contractors got more and more the functions of project management and coordination. Demands of the owner of the building contract, increasing number of participants, new forms of contracts are examples for developments making the tasks of project management and coordination more difficult.

The theory of 'complex systems' [3] can help to describe and understand the kind of difficulties and it also can contribute to develop improvements.

'Complex systems' are identified by two characteristics: 'variety' and 'dynamics'. 'Variety' makes a system complicated and 'dynamics' evolves a system to a 'relatively complex system' and a 'complicated system' to an 'extreme complex system' as well [3].

The 'variety' consists in the number of participants of a construction project, in the numerous technical methods to accomplish construction tasks and it consists also in several kinds of building contracts and their variations. The 'dynamics' consists in changeable circumstances of the economic, political and social environment of the construction firm and the project. Typical dynamic problems consist in changes of persons. Changes in the own organization and also changes in the organizations of the owner or the subcontractors can be difficult.

To accomplish the challenges of the so called 'structural complexity' of the systems, like described before, 'functional complexity' is re-quired. That means instruments to accomplish the challenges of planning and decision-making are characterized by 'functional complexity': Organi-zation, structures and rules should be compiled able to react appropriately on the challenges.

3. The 'Decision oriented controlling-approach'

An instrument to improve planning and decision-making is the 'controlling' considered as a function to support the management. In differentiation to the

American 'management accounting' focusing on tasks of accountancy, the German 'controlling' [4] aims with a strategic attitude on coordination of the systems to plan and control and also ensure the provision with information. The 'Decision oriented controlling-approach' bases on this theory.

To improve planning and decision-making, structures and systems should serve to anticipate coming developments early. Therefore controlling has to deal more with the decisions and planning procedures than with its outputs. And also the controlling endeavors to improve systems and structures of planning and decision-making.

To accomplish these demands the following functions of controlling are defined: 'Under-standing', 'transparency', 'communication' and 'documentation'. The functions of controlling are characterized by coherences. The essential aim is to understand the circumstances of planning charac-terized by 'structural complexity'. To obtain the understanding 'transparency', 'communication' and 'documentation' are often helpful.

Several instruments of controlling are possible and designable to accomplish the functions of controlling. To integrate the instruments of controlling the 'Concept for planning decision-making procedures' is suggested. It consists of six elements:

1 Clearness and coordination of aims,
2 Identification of challenges of planning,
3 Classification of the subjects of planning,
4 Continual review to coordinate aims and planning,
5 Information processing,
6 Evaluation of planning and decision-making.

Especially for the performance of the element 6 we have developed a special method: 'Method to evaluate planning and decision-making'.

This method serves to evaluate the planning and decision-making procedures in order to six determined criterions:

1 Orientation on targets,
2 Accomplishment of complexity,
3 Complete use of Know-how,
4 Progress of planning,
5 Documentation,
6 Communication and information.

We expect, that the dealing with these parameters by the involved staff members causes the improve-ment of planning and decision-making. The method makes the user to determine the aimed level of the six criterions on the one hand. On the other hand the user has to review the degree of accomplish-ment of the several criterions in practice.

Conclusions

A mix of intuitive decision-making and analytical decision-making as well is desirable, but either just intuition and experience are dominate or an overloading with methods is to deplore.

To improve this insufficient situation we suggest the so called 'decision oriented-controlling', dealing with the planning and decision-making procedures. As instruments of the controlling we suggest the 'concept for planning decision-making procedures' and also the 'method to evaluate planning and decision-making'.

The application of the concept and the method causes transparency and communication between the participants of the planning and decision-making procedures to provide the understanding of the structural complexity and also to support the functional complexity.

References

[1] Carrillo, P., Robinson, H., Al-Ghassani, A., Anumba, C. (2004) *Knowledge Management in UK Construction: Strategies, resources an barriers*. Project Management Journal (April), 46-56.

[2] Robinson, H.S., Carrillo, P.M., Anumba, C.J., Al-Ghassani, A.M. (2004) *Developing a business case for knowledge management: the IMPaKT approach.* Construction Management and Economics, 22, 733-743.

[3] Malik, F. (1992) *Strategie des Managements komplexer Systeme : Ein Beitrag zur Management-Kybernetik komplexer Systeme.* 4. Aufl., Haupt, Bern, Stuttgart, Wien.

[4] Horváth, P. (2003) *Controlling.* 9. vollst. überarb. Aufl., Verlag Franz Vahlen GmbH, München.

Logistics services as a special task in construction industry

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Logistics processes on construction sites are considered only as supporting services. Because of the secondary importance of the logistics processes comparing to the construction processes essential improvements of logistics processes on construction site have not taken place for a long time. Only a few concepts providing the management of logistics processes on the site and coordinating the participants of logistics processes are to be recognized.
The paper suggests several organizational concepts to realize logistics management on the construction site. One important benefit is the prevention of 'bottleneck problems' by coordination of processes and participants. Another essential benefit consists of favourable preconditions for implementation and using computer programs to provide planning and control of logistics processes.

Keywords: Logistics management, coordination on the site, project organization

1. Introduction

Logistics processes represent an integrated part of the construction processes. But logistics processes are often not considered as separate procedures which include possibilities for improving the project realization in order to obtain a better completion of several aims of the project management.

There are in practice of construction management only a few single concepts of improving logistics on the site to recognize. Furthermore several computer-based instruments have been quite suggested by research works to provide planning and control logistics processes on the site [2], [3], [5]. Regarding implementation and using of such instruments favourable preconditions referring to management, organization and innovation have to be considered [2], [3].

This paper focuses on organizational aspects of logistics on the site. Several concepts of realization of logistics management will be represented.

2. The significance of logistics processes

Construction works are characterized by numerous logistics processes. In some cases logistics tasks can not be separated from the construction tasks, for example earth works. Especially interior works of larger buildings are signified by several logistics processes, able to separate.

Studies [1] have shown that the share of logistical activities referring to the overall time of interior works is up to 40 %. Reasons for loss of time are unavailable material, deficient building site facilities, insufficient orientation, detouring because of unfavorably stored material. These aspects illustrate the necessity of coordination of the logistics processes especially for the phase of interior works.

3. Possibilities of improvement

For the phase of interior works several possibilities of improvement logistics on the construction site are to be recognized.

The essential aspect is, that in the phase of interior works numerous subcontractors works on the construction site at the same time. Bottleneck problems are to expected because the subcontractors get delivery transports of material, he needs time and place for unloading of the material and he has to store the material on the site and to transport it to the working place. Furthermore the waste material is to be disposed.

The concept of logistics management of the German logistics-management firm 'bauserve' consists of several activities to provide the construction management on the site: Coordination by logistics manager, registration of the amount of waste fair according to the causer involved, check of cleanliness and orderliness, coordination of storage areas. With these activities of logistics managements several benefits are connected, for example: Cost saving by specialization, advantages in scheduling, reduction of conflicts, increase of work safety, improvement of accuracy in cost allocation.

The central element of this concept is the logistics coordinator to submit the construction-management board of the general contractor.

4. Organizational concepts

To realize logistics management on the site different organizational concepts are developed:

Concept I.A (Logistics coordination by the general contractor): The general contractor installs a special logistics coordination entity as part of his project-management board.

Concept I.B (Logistics coordination by the general contractor): The general contractor engages a third party to transmit the task of logistics coordination to it.

Concept II.A (Logistics coordination by the general contractor by order of the principal): In this case the logistics coordination can be performed like in concept I.A as well as in concept I.B. The essential difference is that the logistics coordination takes place by order of the general contractor.

Concept II.B (Logistics coordination by order of the principal of the project performed by a special logistics-management firm): The principal engages a logistics-management firm and binds all contractors by contract to cooperate with this firm. In this case the principal can take more influence on the logistics-management firm and on the conditions of the contract.

Concept III (Project Management in logistics): A comprehensive concept of management focusing on the logistics organization. It enforces the planning of the logistics processes in an early stage of planning of the project. The questions of the logistics become a primarily importance.

5. Conclusions

Logistics processes can be considered as supporting processes for the construction processes and they are characterized by significant potentials of improvement.

Improvements of logistics processes can result in a better work safety, reduction of conflicts and further benefits as explained in the paper.

To realize logistics management on construction site several organizational concepts are suggested.

6. References

[1] Boenert, L., Blömecke, M. (2003) *Logistikkonzepte im Schlüsselfertigbau zur Erhöhung der Kostenführerschaft.* Bauingenieur Band 78 (Juni), 277-283.

[2] Chahrour, R., Utsch, J.H., Franz, V. (2005) *Computersimulation im Baubetrieb – Wege zur Innovation.* Tagungsband 18. ASIM Symposium Fortschritte in der Simulationstechnik, SCS Publishing House e. V. Erlangen, 548-553.

[3] Chahrour, R., Utsch, J.H., Franz, V. (2006) *A Comprehensive Approach to Implement Simulation in Construction Sites.* Proceedings of the 2nd Specialty Conference on Leadership and Management in Construction, PM Publishing, Louisville, Colorado, USA, 58-66.

[4] Sikka, S., Dawood, N., Marasini, R. (2006) *An Integration of Construction Site Logistics & Associated Vehicle Movements towards a Sustainable Construction.* Conference Proceedings of the Joint International Conference on Computing and Decision Making in Civil and Building Engineering, Bibliotheque du Quebec, Bibliotheque du Canada, Canada, 1062-1069.

[5] Vidalakis, C., Tookey, J. E. (2006) *Conceptual Functions of a Simulation Model for Construction Logistics.* Conference Proceedings of the Joint International Conference on Computing and Decision Making in Civil and Building Engineering, Bibliothèque du Quebec, Bibliothèque du Canada, Canada, 906-915.

Innovation and technology diffusion in construction by means of strategic niche management

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The diffusion of new technologies in the market is usually a complex and difficult process with a varying degree of success, not to say a high likelihood of failure. The SNM approach provides an evolutionary framework that is supposed to give a better insight into the reasons why new technologies may fail to catch on, even though they promise superior performance compared to incumbent technologies. The leading question in this paper is whether and how a wider diffusion of new technologies in the construction industry can be achieved by using the Strategic Niche Management (SNM) tool. The 2 case studies -carried out in the construction industry by using the Innovation Theories and the SNM approach- show how socio-technical niches can be created and managed and how this could contribute to the wider diffusion of new technologies in the construction industry by building upon these niches.

Keywords: Strategic Niche Management, Innovation, Diffusion, Construction Industry.

1. Innovation, diffusion, technological regimes and strategic niche management

The core concepts in the evolutionary theories are innovations and technological regimes within innovation systems, the network of interrelated individuals, organizations and enterprises who share a common field of knowledge and interest regarding innovations.[1] *Technological regimes* are seen as a pattern made of knowledge, rules, regulations conventions, consensual expectations, assumptions, or thinking shared by stakeholders in an innovation system, characterizing the professional practices and guiding the design and further the development of innovations [2] *Innovation theories* point at *technological regimes* as key elements in diffusion of new technologies. The diffusion of an innovative technology is considered to be successful if it fits in the prevailing technological regime that characterizes the professional practice of actors in the innovation system. [3] The *Strategic Niche Management* (SNM) approach advocates the creation and management of niches, in which new technologies are given opportunities to incubate and mature through gradual experimentation and learning by actor networks of producers, researchers, users, governmental and other organisations.[4] Historical evidence learned that new technologies often received some kind of protection and support, usually in the form of stimulating a particular market demand and technology development programs, which created a niche for a fledging technology. The SNM approach can be seen as a network approach. It considers the technological environment as a sort of network among innovations equivalent to the innovation system as the organizational environment in which innovation takes place. Nodes of the network are innovations. Technological niches are carried by networks actors (innovation system - the institutional framework-) and by a set of assumptions, professional standards and principles (technological regime). Different actors in the innovation system may be the niche manager: policy makers, a regulatory agency, local authorities, a citizen group, private company, an industry organization, or a special interest group [4] The case studies. that are described in the following sections were carried out in the construction industry by using the Innovation Theories and the SNM approach to find out how socio-technical niches can be created and managed and how this could contribute to the wider diffusion of new technologies by building upon these niches.

2. The case of an innovative construction technology for residential construction in Costa Rica

The subject of this case study is an innovative prefab bamboo (PB) system: a modular system with industrialized prefabricated panels for external and internal (partition) walls, floors and roof panels, etc. The major construction systems that are traditionally used for dwelling construction in Costa Rica are concrete systems (> 90%): concrete blocks (CB) -the most applied system- and various prefab concrete panels (PCP). In 1995 the prefab bamboo (PB) system had a minor market share (3%). The PB system appeared to score better than the traditional systems in technical, ecological and economic sense. Social acceptance is relatively low due to the prevailing technological regime. The PB system was developed in the framework of the non-profit National Bamboo Project in which a tight network –a sub-innovation system- of collaborating actors closely worked together and motivated to reach the targets. The PB system flourished in the protected and supporting environment of the NBP and its tight network, The NBP activities were taken over by Funbambu after 10 years. The PB system lost its preferential position and there was no great breakthrough of it in the construction market. The failure to establish a further strong diffusion of the PB system can be attributed to (a) the disappearance of the tight network with supporting actors, financial measures and support; (b) a general lack of information about the new systems (c) the dependence of the activities on foreign and public financing; and (d) the politic-economic considerations during a certain periods of administration.

3. The case of an innovative construction technology for residential construction in Indonesia

The subject of this case study is a foreign innovative construction technology that comprises lightweight foam concrete (FC) blocks and elements for external and internal (partition) walls, floors and roof tiles, etc.; either pre-cast or cast in situ. Most commonly used construction technologies for houses in Indonesia are Red Bricks (RB), Batako (Ba) and concrete blocks (CB) masonry. The innovative FC system showed to have some advantages compared to the traditionally preferred construction technologies. The FC system was developed and introduced in the Indonesian construction industry by an Indo-Dutch company which successfully applied it in the health building sector. However there is not much experience in building such dwellings with the FC system among the actors in residential construction West- and Central Java. The prevailing technological regime appeared to hamper the take off of the diffusion of the innovative FC technology. Although the relations between the actors in the innovation system of the residential construction sector are generally mainly based on personal contacts and take place on ad hoc basis -unless a project is realized and a building team has weekly meetings with other actors- the relations of the FC system introducing company with other organizations and institutes were at the time of the case study not yet enough established, whilst this is highly needed for the dissemination of information and technologies.

4. Conclusions

The Innovation Theories and the Strategic Niche Management approach as applied in the case studies have resulted in valuable data.
The case studies showed that the investigated innovative technologies can be considered as a technological niche, since they exists -and are developed- alongside other technologies, whilst they serve a certain domain of application and offer additional advantages compared to the traditional technologies. The prevailing technological regimes and professional practices in the residential construction sector in Costa Rica and Indonesia hamper the diffusion of the innovative technologies. A major bottleneck to tackle in both cases is the fact that the technical and social benefits are insufficiently valued in the market place. By means of SNM niche managers can stand up to intervene in the hampered process of diffusion of the innovative technology to fully benefit from its technical and social advantages. Three mechanisms that are important to diffusion and implementation of innovative technologies are identified in SNM work [4]: (a) formation of networks and strengthening of these; (b) voicing and shaping of expectations; (c) active learning processes among major actors about design and engineering specifications, user characteristics and their requirements, environmental issues, industrial development options, government policies, regulatory framework and governmental role concerning incentives for diffusion and implementation. The first and most obvious path to be taken by the Niche Managers is to strengthen the relations between them and the other actors in the innovation system of the residential construction sector. However this is just a first step on a longer way to achieve a full recognition of an innovative technology among the major actors in an innovation system. Once the possible intervention mechanisms have been determined, then the feasibility of these including the dynamics between the different mechanisms should be thoroughly assessed.

References

[1] Malerba, Franco, (1999) *Sectoral systems of innovation and production*, paper of DRUID Conference on: National innovation systems, industrial dynamics and innovation policy rebuild.

[2] Dosi, G. (1982) Technological paradigms and technological trajectories. *Research Policy* 147-162..

[3] Douthwaite, B. (2002). Enabling Innovation: A practical guide to understanding and fostering technological innovation. Zed Books:London, UK.

[4] Schot , J.W. & Rip, A. (1996) The past and future of constructive technology assessment, in: *Technology Forecasting and Social Change* (54): 251-268

Systems thinking approach to supply chain integration in construction

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The construction supply chain and its organization and improvement has been a subject of interest for many years. Based on the industry peculiarities, construction supply chains tend to be is relatively fragmented, the production environment is relatively unstable, and the efficiency levels are relatively low. In this paper, supply chain integration is proposed as a solution to these issues, in terms of proposing repetitive business and production strategies, and strategic collaboration between parties in the construction supply chain. The solution proposed in this paper is presented through systems thinking and a constructivist approach to the organisation and configuration of the construction supply chain. `

Keywords: Construction, model building, organisation, supply chain integration, systems thinking
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1. Introduction

Particularly in an industry that has been deemed to be very disintegrated, supply chain integration has been coined very often as a 'solution to many problems'. Also the restrictions of supply chain integration have often been discussed, while constriction supply chains are often temporary, set up for one-off projects. In this paper, the idea of introducing systems engineering is proposed to promote the possibilities and levels of supply chain integration in construction.

2. Supply chains as systems

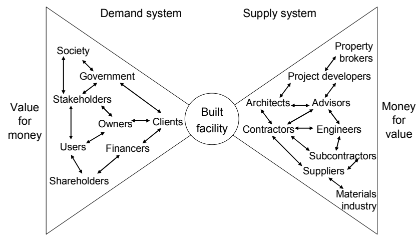
Supply chain can be viewed as a system [1]. A systems approach to the design of a supply chain can benefit the formation of the supply chain, and the achievement of its goals. As supply chains consist of networks of firms, Rouse [2] considers the nature of enterprises as systems, and supply chains as 'systems of systems'. Systems approaches are not fully capable of capturing 'soft factors' such as power and trust, interdependency and human factors.

3. Systems theory and engineering

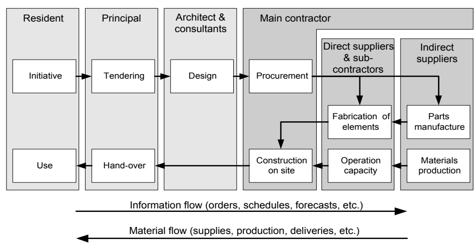
Systems theory views the world in terms of collections of resources and processes that exist to meet subordinate goals. Two aspects of systems theory are of particular importance for supply chains: synergy and entropy. A supply chain relates to the system taxonomy of a production line: functional (dynamic), purposive and mechanical. And in terms of systems typology, supply chains are designed systems, in contrast to natural systems. Besides supply chains are human activity systems and social systems, consisting of actions performed by individuals and groups of individuals, i.e. firms [3].

4. Construction supply chain

The construction industry has been characterised by complexity. This has great impact on the organisation of production, and thus also on the configuration and coordination of construction supply chains [4]. Construction involves a vast network of actors of different kinds around a project, i.e. the development and construction of a built object.

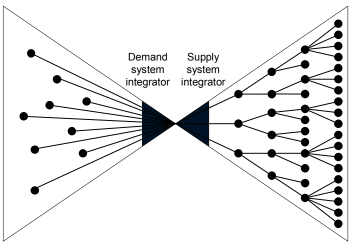


Construction supply chains are converging make-to-order supply chains, caused by the fact that most construction projects are one-of-kind and built on site [5]. The end-customer is of the start and the end of the entire process, and therefore the customer and end-users are of great importance.



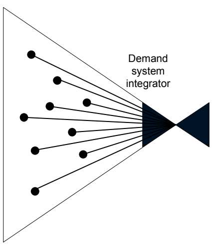
5. Supply chain integration

In construction, the demand and supply systems are often not well integrated. In essence this seems logical because integration of the systems would practically be rather complex and costly. And this is increased because of the one-off approach and sometimes large projects. Paradoxically, on the other hand, there would actually be a need to integrate both systems more to align the large number of parties involved, in order to gain effectiveness and efficiency benefits. Demand and supply system integration in construction implies higher levels of integration at both the demand and the supply side. This calls for two new central roles in the demand and supply system: the demand system integrator and the supply system integrator. The client organisation responsible for the procurement could take up the demand integrator role; the main or prime contractor could take up the supply integrator role [6].



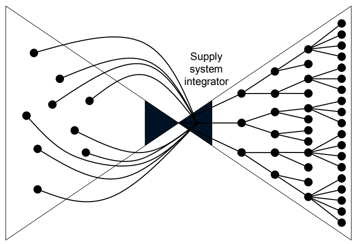
5.1 Client-driven supply chain integration

In many cases the client is the representative of many clients, users, stakeholders etc. Here, the client is the demand system integrator who is taking care of the procurement of the built facility. The way in which procurement takes place influences the degree of supply chain integration, which again influences the supply chain performance and ultimately the value that is delivered to the client.



5.2 Supplier-driven supply chain integration

At the supply side, independently from the demand, parties may evolve towards more integrated production and business formats, through project-independent collaboration with other parties in the supply chain as well as internalisation of neighbouring activities or businesses. In both cases operational and competitive advantages, through higher levels of productivity and efficiency as well as delivering better client value must be the drivers for this kind of supply chain integration. Normally this development is lead by one focal firm, the system integrator; this could be a main contractor, but also an architect or materials supplier



References

[1] Hassan, M.M.D. (2006). “Engineering supply chains as systems”. System Engineering 9 (1), 73-89.
[2] Rouse, W.B. (2005). “Enterprises as systems: essential challenges and approaches to transformation”. System Engineering 8 (2), 138-150.
[3] Checkland, P. (1981). Systems thinking, systems practice. John Wiley & Sons, New York. 330 p.
[4] Vrijhoef, R. and Tong, M.K.L. (2004). “Understanding construction supply chains: an adaptive network approach”. Proceedings 4th International Postgraduate Research Conference in the Built and Human Environment. 1-2 April 2004, Salford. 685-696.
[5] Lin, F.R. and Shaw, M.J. (1998). “Reengineering the order fulfillment process in supply chain networks”. International Journal of Flexible Manufacturing Systems 10, 197-229.
[6] Vrijhoef, R. and De Ridder, H. (2005). “Supply chain integration for achieving best value for construction clients: client-driven versus supplier-driven integration”. Proceedings QUT Research Week. 4-6 July 2005, Brisbane.

An emerging understanding of the value concept

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Value in building is a subject which in recent years has attracted increased focus. Value delivery towards the customer has high priority in every building project, and concepts such as Value Management, Value Engineering, and Lean Construction are often focal points in practice as well as in research. To work goal oriented with value delivery methods requires however that the value concept should be worked and understood. This paper presents a contribution to how the building industry could perceive the value concept. The presented work is based on a recently finished PhD thesis entitled "Value in Building" working with the value concept and how this value concept can be applied in management, e.g. Value Management, Value Engineering, and Value-Based Management.

Keywords: Value, Concept, Product, Process.

1. Introduction

Building is basically a process which aims at deliver value, in terms of product, services, functions, etc., which fulfills the reasonable needs, requirements, and wishes of the client organization. Traditional value delivery methods are Value Management and Value Engineering. For a while it has been discussed what the differences between VM and VE are, and if there are differences at all [e.g. 1; 2]. However, what one quickly can recognize is that both management concepts focus on value. But what is value? Value for whom? And how is value measured? This is some of the questions which immediate stand out. To answer these questions, the building industry needs to understand the value concept. This has, nonetheless, not attained much attention neither in research communities nor in practice. Instead focus is on the application part of value delivery. This is quite understandable, but in this paper it is asserted that the full potential of Value Management will not occur before the underling value concept is understood and incorporated in Value Management methods. This paper presents some of the outcome of a PhD research [3] on value in building which ended ultimo last year.

2. Value and values

There is initially a basic and important difference between value in singular and values in plural. Value relates to assessments about product and price and is traditionally of objective nature. Values, on the other hand, are the principles by which we live. They are the core beliefs, morals and ideals of individuals and are reflected in attitudes and behaviors in society. In other words, values are personal guidelines like "*It is against my values to lie*", whereas value relates to a product and its assets, and it is often connected to monetary relations like "*The new Skoda is of great value*".

3. Value(s) in construction

Value has always been used in building in one manner or another, but not consistently due to the lack of a definition of the term. In most building projects value (needs/goals/expectations) are developed and described in the brief. The achievement of this value, determined by the client and sometimes the users, is always the primary objective of a building project. Value has been an object in building management for many years and is actively seen in management philosophies such as Economical Value Added and Value Management. Furthermore, it is described as a job in traditional models of project management. In lean construction value is a major topic, due to the focus on removing none-value adding activities, i.e. waste.

Unfortunately, it can be concluded that values are not widely and consistently used in building – at least not explicitly. In continuation no real theory of how values in an operational manner can be beneficial applied exists. The purpose of introducing values in an organization is to increase performance in dynamic environments. Values are motivators of human action. At an aggregate level, values constitute the corporate culture, norms, expectations, and "ways of doing things" in an organization. Even though values are subtle phenomena, they nevertheless seem to have decisive effects on individual and organizational behavior and achievement. Partnering is a management idea which partly is working with values. The mantra of partnering is trust, openness and cooperation – all very personal elements. In a partnering environment, guidelines to good/right cooperation is set up, and these are (or should be) based on common values. A successful cooperation is, therefore, a situation where there is a high degree of congruence between the individuals' values.

Values as a concept have received little attention in Lean Construction. When looking for the perception of values as human values most is found implicitly in the research, i.e. between the lines.

4. Product value & process values

A transformation of the value concept into the context of building projects is not straight forward. Some suggest that the two types of values could be identified as product value and process values [4; 5].

- *Product value* relates to the physical construction. It consists of elements such as utility value, architectural value, cost and market value (price).
- *Process values* are related to the activities of the building process, and are hence connected with human activity and behavior.

5. Characteristics of the value concept

In the nature of value lie some characteristics, which might not be clearly understandable. These characteristics are both applicable for product and process values.

- *Subjective*. To create value is not to create products, but products with certain characteristics and qualities in relation to the user of the value.
- *Relative*. This implies that value is essentially comparative. Goods do not have value on their own. Goods only have value in comparison with other goods.
- *Context dependent*. Value should always be evaluated in connection with the context it should be used.
- *Dynamic*. Value(s) changes over time. Partly in relation to the building and its use and partly in relation to the building process.

Another peculiarity of value is the difficulty in measuring value. The measurement problem is grounded in at least two factors, the subjectivity of value, and the difficulty in making value statements explicit – you cannot measure something you do not know. In defiance of the problems it is important to be able to measure value, if used in management.

The importance of process and product values for different groups of partners in a building project differs. The work carried out on the construction site is a main part of the building process, and workers care mostly about the process values, e.g. good cooperation, agreement discipline, communication, etc. and of course also their income. The end users are going to live or work in the constructed building, and they, therefore, care mostly about the product values, e.g. brick type, roof light, flexibility, etc. This hypothesis has been proven in one building project [3]. It is a paradox that the workers in general care mostly about process values, but at the same time they are the ones who add value to the final product. Thus, the workers do not neglect product values. Basically, workers are proud people and like to make good craftsmanship IF the conditions allow it.

6. Conclusion

The great potential of working goal oriented with value delivery will first occur when then concept of value(s) is fully understood. This paper presented a perception of the value concept as consisting of two different value paradigms, namely value related to the product and values related to the cooperation between the project participants - product value and process values respectively. Both perceptions of value is important to focus in a building project, it can however be argued that the main focus should be on product value delivered to the client. This is the real end goal of any project. The process values can however nurse and facilitate the cooperation between project participants, and hence improve the capturing, designing, and delivering of product value to the client organization.

References

[1] Green, S. D. 1997, *New Directions in Value Management.* Hong Kong Institute of Value Management International Conference: Effective Change through Value Management.

[2] Kelly, J., Morledge, R. and Wilkinson, S. 2002, *Best Value in Construction*, Blackwell Publishing, Oxford.

[3] Wandahl, S. (2005). *Value in Building*. Unpublished PhD Thesis, Aalborg University.

[4] BEC 2003, *State of the art - Value Management*, Byggeriets Evaluerings Center, Copenhagen.

[5] Wandahl, S. and Bejder, E. 2003, *Value-Based Management in the Supply Chain of Construction Projects.* 11th Annual Conference on Lean Construction, Blacksburg,

Long run relationships, vertical integration, and international competition: can they explain regional construction cost differences?

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The existence of opportunistic behaviour by contractors or sub-contractors in the bidding process encouraged by the governance structure of construction companies as well as the kind of relationship that exist between contractors and clients is thought to have some bearing on the rising construction cost observed in some regions of Sweden. Three hypotheses that are intended to test the impact that long run relationship between contractors and developers, vertically integrated firms, and the increase of international competition could have on the construction cost increase levels were tested on a predetermined number of projects from six cities in different regions. The semi-structured survey produces inconclusive results. Long run and collaborative relationship was prevalent in small region though respondents in this region did not draw strong connection between construction cost increase levels and the kind of observed relationship. In Stockholm region short-term relationship was mostly prevalent. Vertical integration and foreign competition impacts on construction costs were not significant in either region.

Keywords: Construction costs, vertical integration, long-term relationship, competition

1. Introduction

Swedish housing construction costs has risen more than the rate of inflation during the last decade. The effect of the construction costs escalation was not evenly felt in all regions and there was also an imbalance of housing stocks in various regions [1]. Some regions of the country i.e. metropolitan regions (Stockholm, Gothenburg, and Malmo) experienced a soaring construction costs whilst small regions felt lower construction cost increases [2]. The supply of new residential apartments stagnated at the same time the constructions costs were high particularly in the metropolitan regions where the housing demands were stronger. In order to unearth the roots of escalation construction costs disparities between large and small regions, one can put the lenses solely on the component of construction costs – direct and indirect costs and anticipate that unit price (labour, materials, and equipments) and overhead costs differences that exist between the regions will explain the observed divergences. Another alternative is to examine other factors such as supplier structure and client-contractor relationship as well as competition and expect that some overhead and transaction costs associated with them would explain the differences of cost escalation between the regions.

2. Background

The cyclicality of the construction industry especially the housing building sector plays big role in determining the longevity of the relationship that exist between contractors and clients or between contractors and their sub-contractors. Swedish vertically integrated firms, which have strong financial muscles to undertake numerous large developments [3] may tender higher price for a new rental or condominium projects. On one hand, winning that contract safeguards the prices of other similar properties own by the integrated firm. On the other hand, not winning the tendered contract will not exempt them developing rental units or condominiums of their own and still be competitive in the market. They can divert those resources e.g. machinery and equipment to other projects undertaken by the firm without incurring too much loss of productivity. Their strong financial position also allows them to survive even if they loose few customers by raising opportunistically the construction costs. Presence of foreign contractors and subcontractors may not only increase the competition and lessen the dependency of fewer actors in the deliverance of building projects but it also enhances the availability of construction workers as well as cost-effectively construction materials. The cost of construction materials, which constitute approximately one-third of total construction costs, have shown price increases over and above other industrial products, with price rises even during periods of low demand [4]. One of the reason is that construction trade is concentrated to a small number of large companies i.e. one company accounts for more than 50% of total sales of cement, reinforcement steel, and plasterboard.

3. Methodology and project descriptions

One of the approaches of comparing costs of buildings is functionally similar building approach [5] that seems to be suitable in our regional comparative study. Other approaches seem to be theoretically possible but practically difficult to carry out due to the differences that exist in architecture, standards, availability of projects, etc. The third approach of typical, functionally similar buildings is suitable. A semi-structured survey was carried out in Stockholm and five medium cities that are deemed to represent regions for both escalating and non-escalating costs. A total of 52 projects were included in the survey and 33 of them responded the questionnaires. Projects that were built between 1998 and 2003 are considered in the survey since that period encompasses both high and low construction activities. Only projects that contain more than 20 units and equipped with elevator were chosen in order to have functionally similar buildings.

4. Survey results

In Stockholm, respondents believe that construction costs were higher in those years because of market conditions (high demand) that were in favour to contractors. In other words, contractors have had the upper hand and selected only those projects that they could make extra profit and developers were competing for the few contractors that were offering their services. It has also been indicated that medium size construction companies with 50 or less employees are dominant in the residential construction market in non-metropolitan cities that makes competition among them highly noticeable. Most of the developers in big region agree that long run relationship (LRR) would decrease construction costs while the opinion of the developers from small region about LRR affects on construction costs is mixed. Only one third of them agree that long run relationships decreases construction costs while two thirds either believe that LRR has no implications on construction costs or simply do not have opinion.

- With regard to the hypothesis that a long run relation ship between contractor and client tends to a lower cost increase during the boom, Mann-Whitney U test shows that we can reject the null hypothesis (10% significance level) that there are no differences in developers' opinion of whether long run relationship between contractor and developers affects construction cost increases. The existence of long run relationship in the small regions may have helped to prevent opportunistic behaviour between the parties though only one-third of developers in the small region acknowledged the benefits of this relationship
- The null hypothesis that postulates vertically integrated contractors operating in both regions do not tender higher prices than non-integrated contractors was also rejected at 10 percent significance level. Developers on the Stockholm region, where higher construction cost increases of the projects are observed and most of the projects are constructed by vertically integrated firms, have different perception than small region developers who believe that vertically integrated firms tend to tender higher prices. The responses of small region developers may have driven by concerns that the market power of a vertically integrated firm could lead to unfair pricing whilst the responses of Stockholm region developers could be motivated by the desire of having long run relationship in the face of high competition and high construction activity that encourages market driven attitudes
- The final hypothesis that regards the foreign contractor and subcontractor participation would decrease construction cost was statistically validated. The null hypothesis that there are no differences in developers' opinion about the impact of foreign supplier presence on construction costs was rejected at 10 percent significance level

References

[1] Atterhög, M. and Lind, H. (2004) "How does increased competition on the housing market affect rents? An empirical study concerning Sweden", Housing Studies, Vol. 19(1), 107-123

[2] Lind, H. (2003) "Bostadsbyggandets hinderbana: En analys av utvecklingen 1995-2001", ESO, Finansdepartementet, Ds 2003:6

[3] Swedish Industry (2004) "Construction Industry and Infrastructure", The Swedish Institute

[4] Villy Bergström, Deputy Governor of the Cenrtal (2001), Bank (Riskbanken). Speech: Stable prices, wages and growth important for construction sector

[5] Vermande, M. Henk and Mulligan, P.H. Van (1999) "Construction costs in The Netherlands in an international context", Construction Management and Economics, Vol. 17(3), 269-283

Clients as initiators of change – barriers to increased influence over project results

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Construction clients are often regarded as acting in the capacity of 'change agent' because they initiate and lead change projects through suitable procurement procedures and management processes. This paper presents an empirical investigation into obstacles that Swedish construction clients face in order to achieve increased influence over the end result of the construction process. Attitudinal and industrial barriers are perceived as the most critical. Furthermore, clients using external project management and those who are active in national markets perceive these obstacles as even more critical.

Key words: Construction clients, change agents, barriers to change, project management

1. Introduction

Two major investigations of the Swedish construction industry highlight the role of the construction client as a 'driver' for change in the industry. Local clients are usually more personally involved in the construction process and have therefore more influence over the end result of the construction process [1]. The client does not carry out the construction process alone; a temporary project organisation is created in order to manage the process. Some parts of the client function, such as project management (PM), have during the past decade been transferred to external organisations. The purpose of this paper is to identify barriers to change, faced by clients, in order to achieve increased client influence over the end result of the construction process. Furthermore, we investigate how the variables of size of clients' market and extent of external PM influence perceptions of important barriers.

2. Barriers for change in construction

In change management literature, many types of barriers can be identified. In this brief literature review potential barriers are divided into three different levels: individual (attitudinal), organis-ational and industrial.

2.1 Attitudinal barriers

People and their attitudes constitute a barrier to change. In the construction industry there are many attitudinal aspects that can arise as critical barriers to change. Kululanga et al. [2] argue that the lack of a learning culture, where existing values and beliefs are not open for questioning, is characteristic for the industry, thereby constituting a general barrier to change. Construction is a project-based industry, resulting in a narrow perspective both in time and scope. Attitudes are also dominated by short term financial considerations, reflected in uncooperative and suspicious relationships.

2.2 Organisational barriers

An organisational barrier is the traditional use of competitive tendering arrangements in construction procurement since it decreases commitment and flexibility [3]. Another barrier is the traditional organisation of the construction process. The highly specified work is divided into distinct packages that are allocated to different specialists to complete individually. This situation is derived from clients' competitive tendering habits, which hamper integration of work tasks and actors [4].

2.3 Industrial barriers

Industrial barriers (e.g. competitive pressures, government regulations and industry practices) are derived from the organisation's industrial environment and may serve as serious barriers to change [5]. In most countries, public sector clients are very important actors in the construction industry. These clients must follow laws regarding public procurement, which facilitate competition and non-biased procurement decisions. A deep-rooted practice in the construction industry is the heavy reliance on formal standard contracts. Such formal standards can be cost efficient, but hinder flexibility and change.

2.4 The impact of PM

A change process needs a 'change agent' and an environment that is receptive. In the construction process, PM has a central role to play. The project manager attracts high demands from both his superiors and the client regarding time, budget and project mission, which can create a divergent picture of the situation between the project manager and the client. The predicament over external commissioner (i.e. project manager) and external contributor (i.e. contractor, subcontractor and supplier) lies in the formulation of project mission and the internal efficiency of the project [6]. This can be especially problematic since client requirements are frequently tacit in nature and can only be understood through a prolonged process of socialisation [7].

3. Empirical results

A questionnaire was sent to 104 construction clients who are members of the Swedish construction client organisation. 87 responses were received (an 84% response rate). The questionnaire asked for general information about the client organisation such as size of market and the use of external or internal project managers, together with specific questions regarding perceived barriers to change. A scale from 1 to 7 measured the level of importance of each barrier with 1 representing unimportant and 7 representing very important.

Principal component and factor analysis (PCFA) grouped the individual items regarding *barriers to change* into three factors: attitudinal, industrial and institutional. The mean values of the three factors show that attitudinal and industrial barriers are the most critical.

A comparison of means between those clients with mostly external PM and those using mostly internal PM shows that clients with external PM perceived attitudinal barriers as more critical than clients with internal PM. Another comparison of means, between local and national clients shows that national clients perceived both attitudinal and industrial barriers as more critical than did local clients. We also found that governmental and industrial clients mostly use external PM and are more active at the national level than real estate and municipality clients.

4. Conclusions

The quantitative study shows that attitudinal and industrial barriers are the most critical to change in the construction industry towards increased client influence over the end result of the construction process. National clients and those who use external PM during the construction process perceive the attitudinal and industrial barriers as more critical than local clients using internal PM. This supports theories arguing that external project managers have a focus on the project rather than on the product (e.g. to achieve the most sufficient product for the client). It also supports the discussion that the construction business is a very local affair, where local clients have a close connection with the actors in the market.

Local clients with internal PM should have more influence on attitudinal barriers, but their efforts only affect local actors. The national client has a better chance to effect change on a larger scale, but depends more on external management to execute the construction process.

The abovementioned variables (PM and sphere of activities) vary with different types of client. The impact of PM and sphere of activities can therefore affect change in the construction industry (to overcome attitudinal barriers), where the clients act as 'change agents'. Governmental and industrial clients are using external PM to a larger extent and have a more national sphere of activities. Since these two variables affect perceptions of barriers, these types of client should be aware and be prepared to take suitable actions if they want to act as change agents.

References

1. Wennström, A., *The client's role on a local market*, in *Institution of civil engineering*. 2004, Luleå University of Technology: Luleå.
2. Kululanga, G., et al., Learning Mechanisms Employed by Construction Contractors. *Journal of Construction Engineering and Management*, 1999. 125(4): p. 215-223.
3. Ng, T., et al., Problematic Issues Associated with Project Partnering - The Contractor Perspective. *International Journal of Project Management*, 2002. 20(6): p. 437-449.
4. Briscoe, G.H., et al., Client led strategies for construction supply chain improvement. *Construction Management and Economics*, 2004. 22: p. 193-201.
5. Okumus, F. and N. Hemmington, Barriers and Resistance to Change in Hotel Firms: An Investigation at Unit Level. *International Journal of Contemporary Hospitality Management*, 1998. 10(7): p. 283-288.
6. Aulakh, P.S. and E.F. Gencturk, International Principal-Agent Relationship-Control, Governance and Performance. *International Marketing Management*, 2000. 29 p. 521-538.
7. Green, S.D., et al., *Learning across Business Sectors: Knowledge Sharing between Aerospace and Construction*. 2004, University of Reading: Reading.

Industry initiated development program: How to measure the effects?

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Across the industrialised world various initiatives on improving construction performance has been started over the last ten years. In Sweden an industry initiated development program (FIA) started in 2003. Its focus is on improving the civil engineering part of the construction sector. A pre-study has been conducted on how to analyse the performance and improvement of the civil engineering sector. From a literature review and in collaboration with FIA a first draft of the survey was formalised. A test survey was sent out to projects pre-decided by FIA, and the respondents were interviewed about their project in relation to the survey. The result of the pre-study is a ready to use questionnaires and a tool for analysing them against key areas for improvement of the civil engineering sector as stated by FIA.

Keywords: Civil Engineering, Development Program, Measures, Pre-study

1. Introduction

Different initiatives to improve the construction industries competitiveness have been introduced in a number of European countries, for example Constructing Excellence (the UK), PSI Bouw (Holland) and Utmärkt Samhällsbyggande in Sweden. A program aimed at improving the competitiveness of the civil engineering part of construction, FIA (Renewal within the civil engineering sector), was launched in December 2003. The aim of FIA is that the year 2010 their vision should be fulfilled, the vision states:

The civil engineering part of construction is and is perceived as, an important and respected society provider, whom, together, in an innovative and learning process and in a cost efficient manner develops the road and rail infrastructure to fulfil the demands of society and end-customers. The industry has compared with today's situation substantially increased their efficiency and lowered the frequency of faults. (Free translation from Swedish)

To achieve this five aims have been defined:

- Increased efficiency
- Better teamwork and increased cooperation
- Better incentives for R&D
- More efficient dissemination of existing knowledge and competence
- Recruitment of new personnel made easier by the more positive image of the industry.

From this aims several different research and development projects has been and will be initiated by FIA to achieve these aims. FIA saw a need to monitor how the civil engineering sector develops, in order to effectively plan and implement development projects. As a result the Division of Construction Management, Lund University was commissioned by FIA to conduct a pre-study. The purpose of the pre-study, which is presented in this paper, was to design a survey that can continuously be sent to civil engineering projects, in order to measure key indicators of change.

2. Measuring the effects of operational change

There is common saying "if you cannot measure it, you cannot change it", emphasizing the need to monitor the results of change to ensure that the expected results is achieved. There have been different efforts to measure change in construction, these have had different scope and subsequently different approaches. It is also possible to see overall changes in industry performance over time when comparing project scores between different times.

3. Development of the survey and questionnaire

The construction of the survey was undertaken with two main requirements from FIA. Firstly, the survey was limited to just cover the internal aspects of civil engineering projects in the design and implementation phases. Secondly, the survey was required to be as easy as possible to answer by the respondents. One effect of this was that the number of question was to be as few as possible. The challenge was thus to find a balance between the numbers of questions required to sufficiently cover the aims and limitations of the study and at the same time have a limited number of questions to ensure a survey that was easy enough to answer.

4. Discussion

This survey will not directly measure the effect that FIA has on the civil engineering sector. What is measured is the direction of change for the Swedish civil engineering sector during the years that FIA is active. This knowledge could indirectly be used by FIA to initiate additional studies concerning specific subjects that could guide the civil engineering sector in a desired direction concerning their five main aims.

The survey design was constructed in close cooperation with representatives of clients, contractors and designers active in the civil engineering sector in FIA. The main client organisations for civil engineering projects in Sweden are the National Road Administration and the National Railroad Administration, whom both are supporters and contributors to the activities of FIA. These organisations can by contractual means demand the actors in their projects to fill out the questionnaire, which will ensure a sample size large enough not to compromise the reliability of the variables.

The downside of this close cooperation with the sector can be that the researcher will have to adopt the survey design to the requirements of the sector. In this case, although the representatives of the sector had requirements on the design of the survey they trusted the researchers to have the choice of decision when altering or removing questions. This trust is imperative to ensure the scientific quality of an industry-initiated survey. In addition it is important to test the survey before full-scale usage. The test survey and the interviews with the respondents did not show reasons for any major changes of the survey.

Housing investments in 12 West-European countries between 1976 and 1999

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Housing investments has both a direct and an indirect effect on economic growth and, therefore, it is of great importance to understand the mechanism underlying the housing market. In the present paper, an error correction model is used to analyze the dynamics of the housing markets in 12 West-European countries over the period 1976 to 1999. The empirical results indicate that it is to some degree possible to consider the European housing market as one market. The relationships between housing stock and its macroeconomic determinants are robust across the countries. Furthermore, the result shows that price and cost elasticity on housing supply are low. Shocks on demand and supply have small effects on the housing stock (low speed of adjustment on quantity), but on the other hand a substantial effect on prices (high speed of adjustment on price). Supply side shocks has an instant effect on housing prices and demand side shocks takes on average four year before it is fully incorporated into the prices.

Keywords: Housing market, stock and flow model, error correction model, housing supply, housing dynamics

1. Introduction

As housing investments is used as tool to promote economic growth it has become increasingly important to understand the mechanism underlying the housing market. Explicit or implicit assumptions about the price elasticity of housing supply can have huge policy implications. For example, what is expected to happen on the housing market in a situation of demand or supply side shock? Is it more reasonable to expect changes in quantity or changes in prices? In addition, how long can we expect the shock to persist, i.e., how long is the speed of adjustment to new market situation in the housing market?

The objective with the present analysis is to:

(1) Analyze what determine housing supply in 12 European countries,

(2) Estimate the long- and short-run dynamics including the stock and price adjustment effect

(3) Estimate the price elasticity for consumer housing price and construction cost on housing supply and the price/income elasticity on housing demand

(4) Use a stock and flow model in the framework of an error correction model utilized on panel data.

2. Literature review

Estimation of the long run and short run relationship between housing supply and its determinants has been performed with two different approaches. First, estimation of the housing stock in levels or housing investments on income, cost of capital and other cost shifting variables, and second (see e.g. Lee [1], the estimation of the reduced form, and especially the reduced price equation, on the change in income and the change in the cost shifting variables (e.g. Malpezzi and Maclennan, [2]). Recently, the two approaches have been modeled together in an error correction framework as in Riddel [3].

Riddel [4] defines the supply of housing to be a function of prices and cost-shifting factors and the demand for housing to be a function of price, income, interest rates, and the price of houses in neighboring areas. To allow for stock and price adjustment, the change in supply and price is a function of the deviation in stock and price from the equilibrium stock and price, respectively. The results indicate that demand for housing is negatively related to interest rate and positively related to wage and salary income. The demand for housing is mostly influenced by employment. In accordance with economic theory, construction wages and mortgage rate are inversely related to the stock together with vacancy rates. The estimated speed-of-adjustment parameter is negative; that is, if the actual housing stock is larger than the equilibrium housing stock, housing investment will decrease. The price adjustment dynamics are negative and of reasonable magnitude. If the price level is higher than equilibrium price, prices are corrected by price depreciation. However, as Riddel summarizes the results, developers seem to answer more correctly to disturbances on the supply side than on the demand side. Riddel's explanation is that this is a result of information asymmetries.

An interesting article by Riddel [3] investigates housing markets prices and housing stock dynamics in the United States over the period 1967 to 1998. She does that by utilizing a disequilibrium framework to distinguish between supply side and demand side shocks. First, she separately estimates the long run demand and supply equation. Second, the deviation from long run equilibriums is used in two flow equations, the demand and supply equation. The overall results indicate that housing construction is more effected by supply side disequilibrium and housing prices are more affected by demand side disequilibrium. The long run price elasticity of supply is estimated to be between 0.0025 and 0.49, i.e., in the line of Mayer and Sommerville [5].

In a recent article by Harter-Dreiman [6], the price elasticity of the supply of housing is investigated by the use of panel data set consisting of 76 MSAs in U.S. from 1980 to 1998. The results from the vector error correction model suggest an elastic long run supply function and a slow speed of adjustment. The supply price elasticity is estimated to be in the range of 1.8 to 3.2. The estimated speed of adjustment is equal to -0.22, i.e., the adjustment from a disequilibrium situation is relatively slow.

3. The methodology

In the present paper is an error correction model (ECM) framework, following Banerjee et al [7], used to analyze the dynamics of the housing markets in 12 European countries in the period 1976 to 1999. However, running regression with non-stationary data produces spurious results, which make it important to test the series concerning stationarity and co-integration.

4. Results

As expected, the error term from the long run housing supply and demand equation enters the stock adjustment equation with a negative parameter estimate. The parameter is statistically different from zero, but low. The results indicate that it takes several years to the stock to adjust from supply and demand side shocks. Riddel [4] estimated the stock of adjustment to be approximately 5 year due to a chock in the supply. The result, in the present study, imply that the European housing market adjust much slower. On the other hand, the price adjustment model indicates that supply and demand side shock have an instantly effect on property prices. For supply side shocks, the estimated speed of adjustment is estimated to be one year and four years for demand side shocks. In summation:

- Estimated price and cost elasticity's are quite low, but comparable with others result. It is interesting to not that the estimates are robust across the 12 European countries.
- Shocks on demand and supply have moderate effects on the housing stock, but on the other hand a substantial effect on prices.
- Supply side shocks has an instant effect on housing prices and demand side shocks takes on average four year before it is fully incorporated into the prices. Hence, housing developers respond slowly to changes in economic fundamentals.
- In the short run, most of the effects will be picked up by adjustments in price. Therefore, subsidize housing constructions seems to have small effects on housing stock, but large effects on property prices.

References

[1] Lee, Gabriel. S. (1999). Housing Investment Dynamics. Period of Production. and Adjustment Costs. *Journal of Housing Economics*. 8. 1-25.

[2] Malpezzi, Stephen and Maclennan, Duncan (2001). The Long-Run Price Elasticity of Supply of New Residential Construction in the United States and the United Kingdom. *Journal of Housing Economics*. 10. 278-306.

[3] Riddel, Mary (2004). Housing-market disequilibrium: an examination of housing-market price and stock dynamics 1967-1998. *Journal of Housing Economics*. 13. 120-135.

[4] Riddel, Mary (2000). "Housing Market Dynamics under Stochastic Growth: An Application to the Housing Market In Boulder. Colorado". *Journal of Regional Science*. 40:4. 771–788.

[5] Mayer, Christopher and Sommerville, C. Tsuriel (2000). Residential Construction: Using the Urban Growth Model to Estimate Housing Supply. *Journal of Urban Economics*. 48. 85-109.

[6] Harter-Dreiman, Michelle (2004). Drawing Inferences about housing supply elasticity from house price responses to income shocks. Journal of Urban Economics, Vol.55, 316-337.

[7] Banerjee, Anindya, Dolado, Juan, J. and Mestre, Ricardo (1998). Error-correction mechanism tests for cointegration in a single-equation framework. *Journal of Time Series Analysis*, 19:3, 267-283.

A multi-criteria decision making framework for alternative payment systems using AHP analysis

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The current practices of payment system in construction industry are many and varied, largely driven by the project nature and types of procurement. However, its successful implementation depends on the suitability and flexibility to accommodat client's needs, project requirements and ease of use of the payment systems. The paper examines an alternative multi-criteria decision making (MCDM) framework that use Analytical Hierarchy Process (AHP) model to analyze the decision making in the selection of most appropriate payment system(s) (PS) with the best potential to deliver an accurate cash flow prediction in a given type of project and client characteristic.

Keywords: AHP, Multi-criteria decision making, pair-wise comparison, alternative payment systems, cash flow simulator

1. Current payment system practices

In the UK construction industry, the normal practice of monthly payment for project participants (i.e. consultants, contractor, and suppliers) used to be made in 30 to 60 days using unit rates and quantities based on the actual work done. Where, typically, in order to avoid negative cash flow the project participants have to manage their working capital by means of overdraft or borrowing from financial institutions. Such arrangement is of vital for financing on going construction operations before any payment received from their clients. However, poor cash management and cash flow forecast will lead to failure to convince finance lenders and creditors, or possible higher cost of borrowings for financing their construction activities [1]. Although such practice has shifted to alternative approaches in recent years for example, the use of mobilization advance payments, stage payments, direct payments and other innovative mechanisms for payments [2]. Nevertheless, according to the 'Trust and Money' [3] and 'Accelerating the Change' [4] reports, the industry has yet ready for these new adoptions. Where, in many cases, conflicting views and determinations from project participants to defend their own commercial benefits making existing payment practices prevailed over the use of innovative payment systems. This scenario is already evident in the National Specialist Contractor Council survey [5]. The survey was found that average wait for payments to be made were: 63% for 30 to 60 days; 20% for 60 to 90 days; and only 7% for less than 30 days. In addition to this, retention abuse (70%) and 'pay when paid' (74%) are among the highest contractual abuse reported by the respondents.

This research aims to investigate industry's perception of payment and cash flow management with the aim to encourage the use of appropriate payment systems and promote these systems as performance enabling mechanisms. The project i.e. Re-thinking Construction using Payment Systems (ReCoUPS) is funded by the Engineering and Physical Sciences Research Council (EPSRC). This research reflects the Government's efforts to improve payment practices across the construction industry i.e. 'Trust and Money' [3] and 'Accelerating the Change' [4]. Meanwhile, the Department of Trade and Industry (DTI) is working on the analysis of the consultation on proposals to amend the current Housing Grants, Construction and Regeneration Act 1996 (Construction Act) and Scheme for Construction Contracts Regulations 1988 (England and Wales) to improve future payment practices for the construction industry [6]. This paper proposes a framework using AHP analysis for MCDM decision-making when selecting an appropriate payment for a construction project with regard to a given type of project and client characteristic. The model will then be incorporated into the ReCoUPS simulator for forecasting construction supply chain cash flow. The simulator consists of four major components i.e. "the process map", "the supply chain", "the pricing system" and "the payment system" using Microsoft applications (VBA, Excel, MSProject, and Access) to develop. Within the simulator, a full project program will be generated using a project management tool. It requires supply chain inputs and decision-making in payment systems to assist which pricing method and payment system to produce the necessary cash flow profile for the client, contractors, and all supply chain members.

2. Research outputs

The proposed MCDM framework aims to assist decision-making in payment system (PS) selection as well as to predict accurate cash flow for construction supply chain, based on a given set of predefined variables when integrated with the cash flow simulator. It is designed to enhance the flexibility of the simulator and its ability to forecast project cash flow accurately to achieve the following objectives:

- the identification of available and alternative payment systems in terms of their supply chain links, pricing mechanisms and payment mechanisms.
- the development of a model that links payment system selection and implementation processes to project requirements and characteristics.
- the development and validation of a computer-based simulator for modeling the outcomes of various payment systems.

To summarize, the developed MCDM tool will ultimately addresses the difficulties relating to payments for contractors and also examines issues affecting consultants, suppliers and other project participants within the construction industry and the effects of selecting an appropriate payment system for the construction supply chain.

3. Methodology

The proposed MCDM tool for PS will be developed using data collected from the UK construction industry practitioners. There will be a questionnaire survey and a series of workshops to investigate industry's perception of payment systems and cash flow to find out the most significant project objectives (PO) (i.e. MCDM attributes) that give impact on the selection of most appropriate PS. This is followed by assigning a 9-points scale for each PO to obtain the respective relative priorities (i.e. eigenvector values) in a paired comparisons matrix. The relative priorities can be calculated using ExpertChoice™ and SuperDecisions software to derive composite relative priorities of PS alternatives. However, to maximize the integration with the developed cash flow simulator. The above mathematical calculation can be achieved using a spreadsheet to perform paired comparisons. Subsequently, the proposed MCDM tool will be integrated with the developed simulator that used a combination of Microsoft Excel, Access and Visual Basic.

In this paper, the proposed AHP model for MCDM framework consists of three main components: a matrix structure of MCDM; paired comparisons analysis of the PO and PS alternatives; and synthesis of the PO and PS priorities into composite measures to yield the most optimal PS alternative.

References

[1] Kaka, A. and Price, A.D.F. (1991) Net cash flow models: are they reliable? *Construction Management and Economics*, 9(3), 291-308.

[2] Njie, G., Langford, D., Kaka, A.P. and Fortune, C.J. (2005) Rethinking construction using payment systems: towards a theoretical analysis framework. *CIB W92/T23/W107 International Symposium on Procurement Systems - The Impact of Cultural Differences and Systems on Construction Performance.* Las Vegas, Nevada, 8-10 February. 645-653

[3] Latham, M. (1993) *Trust and Money. Interim report of the Joint Government/Industry Review of Procurement and Contractual arrangements in the United Kingdom Construction Industry.* London: HMSO.

[4] Egan, J. (2002) *Accelerating the Change. Rethinking Construction*, ISBN: 1 898672 28 1 [www.strategicforum.org.uk/pdf/report_sept02.pdf].

[5] Murdoch, I.J. (2005) *State of trade survey: Quarter 2.* SBE, Northumbria University, February 2006. [http://www.nscc.org.uk/index2.htm].

[6] DTI (2006) *Improving Payment Practices in the Construction Industry.* Published Jointly by the Department of Trade and Industry and the Welsh Assembly Government. [http://www.dti.gov.uk/ construction/hgcra/hgcralead.htm]. Last access: April 2006.

What can we learn from 'knowledge events'?

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To facilitate organizations, especially SMEs, to conduct KM, a simple yet robust approach called Knowledge-Event Management (KEM) has been developed. It uses audio diaries to capture the knowledge events and the debriefing technique to transform their tacit knowledge embedded in these events into explicit knowledge which can be disseminated within the organizations and the industry. The KEM approach has been successfully tested among 12 construction SMEs in the UK, in which 316 knowledge events have been collected. This paper categorizes these events and identifies the most common problems facing the construction industry. Solutions to these problems from the participants are then presented and discussed.

Keywords: knowledge management, knowledge event, SME.

1. Introduction

KM has been studied and explored from different aspects and there are some good practices readily available, such as Knowledge Worker System (KWS) and Arup's "Electronic People Finder" and "Communities of Practice". However, those KM approaches may not be readily applied everywhere as they involve a lot of investment in ICT and may need a dedicated Knowledge Manager, which not every organization can afford. Unsurprisingly, little effort has been directed to small and medium enterprises (SMEs), even less to construction-related organizations. But this does not mean that SMEs do not need or cannot conduct knowledge management. On the contrary, to some extent, SMEs need knowledge management even more as the intangible knowledge assets can provide them a leverage to survive in the fierce competitive market. New KM approaches are required to suit SMEs' needs.

2. Knowledge-event management approach

Personal knowledge is very complex and is not generally available outside the person. However in practice, sometimes knowledge transformation and dissemination does take place through people telling stories about the events they have experienced. A new technique of KM, called Knowledge-Event Management (KEM), has been developed which can not only access the abstract factual knowledge of an activity but also the process knowledge concerning how people involved in the activity think and make judgments in practice [1]. It is based on both cognitive learning theory [2] and the theory of organizational behavior [3]. KEM focuses on "events" and stories about the events. It has three stages: event-collection, debriefing-analysis, and dissemination.

Tacit knowledge is communicated substantively using the spoken language which is rich in meaning because of nuances of delivery, body language and context. This often occurs through the telling of stories about practice. Therefore, KEM uses audio diaries to minimize the disruption to the participants' daily work. The main tool for audio diary entry was a Dictaphone which is a low cost and readily understood device.

The story of the event is not sufficient to make explicit the tacit knowledge and judgment of practice. KEM uses debriefing to engage in this [1]. This acknowledges the fact that the transfer of tacit knowledge requires socialization [4] and so, this knowledge can only be brought out and developed in dialogue with others. Debriefing is a powerful tool, which can make explicit the tacit learning so that it can be transferred to a wider audience and ultimately to the knowledge base of the industry. The debriefing establishes the consequential issues which are what is experienced, the contributing issues which produce the event and the wider contributing issues which set the way that the organization does things generally or even the way that the industry operates. It is these wider issues which cause events to be repeated and where double loop learning can be created and where interventions can be made to prevent the event happening again.

3. The knowledge events

The development of KEM was funded by the Department of Trade and Industry, UK and involved cooperation between 2 universities, 2 construction networks and 12 construction SMEs. The research had 28 participants from the construction companies across the UK participate in the audio diary recording and debriefing. Altogether, 316 knowledge events have been captured in audio form, and 110 debriefings have been undertaken. These audio diaries and debriefings have revealed a great deal of rich information about the operation of projects and the complex decision making that managers have to undertake. Some of these issues challenge current conceptions within companies and thus are positive drivers of change. As well as this, some issues are at a higher level about inter-organizational relations or even industry conduct.

Even though the events that the participants recorded were project and/or company related, many of them were representative of industry-wide problems. The top four categories of events were: lack/late/error of design information (17.3%), unsatisfactory subcontractors work (10.4%), and skills/labor shortage (5.4%). Other frequently mentioned problems are: service connection, client's changing requirements, negligence of health and safety on site, insufficient site condition investigation, claim dispute on extension and cost, material supply and delivery, and record keeping. This supports the need for this technique across the industry.

In the paper, the three major problems revealed from the events collected and the possible solutions perceived by the practitioners are discussed.

3.1 Lack / late / error of design information and design changes

Causes: architects being too busy and not local; lack of checking mechanisms and coordination; leaving contractors to complete the design details; fixed and minimized design fees; clients not knowing what they want; fast track projects.

Solutions: sufficient time for design and detailed clients' brief; proper coordination and management of the design; involving contractors into design early; better education and training for architects; contractors suggesting alternative solutions; in-house design-build contract; and better communication within project team.

3.2 Unsatisfactory subcontractors' work

Causes: lowest price selection; insufficient time for induction and preparation; subcontractors' negligence and poor craftsmanship; and insufficient supervision and monitoring from the main contractor.

Solution: Pre-qualification; supply chain integration; complete design; proper brief and well-prepared site condition; QA system; regular monitor and assessment of subcontractors' performance; and contractor pay subcontractors.

3.3 Skill / labor shortage

Causes: poor industry image; short-term thinking; low profit rate; lack of investment in training; subcontracting.

Solutions: public relation and marketing the industry; diversifying recruitment; not stretching resources too much; apprenticeship and company training scheme; proper briefing and induction; close supervision and monitoring.

4. Conclusions

Among the 316 knowledge events collected from site managers, project managers and quantity surveyors in the UK, the three most frequently mentioned problems are lack / late / error of design information and design changes, unsatisfactory subcontractors' work, and skill / labor shortage. Through debriefing, the practitioners reflected at their events, and identified the consequential issues, contributing factors and the wider learning of these problems. Some may argue that these problems are too common and the solutions are only just 'common sense'. But it is this "common sense" the industry has always ignored and these common problems repeat again and again, hemorrhaging profit from companies and the industry. It is time for the industry to look at these knowledge events, learn from them and prevent the repeated mistakes. Ultimately, the construction industry can improve its performance and provide better service to its clients, leading a sustainable development.

References

[1] Boyd, D., Egbu, C., Chinyio, E., Xiao, H. and Lee, C.C.T. (2004) Audio diary and debriefing for knowledge management in SMEs. *ARCOM Twentieth Annual Conference 2004*, Heriot Watt University, 741-7

[2] Kolb, D.A. (1984) *Experiential Learning*, Prentice-Hall, Englewood Cliffs, N.J.74) *Theory in Practice: Increasing Personal Effectiveness*, Jossey-Bass, London

[3] Argyris, C. and Schon, D.A. (1974) *Theory in Practice: Increasing Personal Effectiveness*, Jossey-Bass, London

[4] Nonaka, I. and Takeuchi, H. (1995) *The Knowledge-Creating company: How Japanese Companies Create the Dynamics of Innovation*, Oxford University Press, Oxford

Risk management in relationship contracting projects – A case study

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As the first project to be procured via relationship contracting in South Australia, the Adelaide Convention Centre Extensions was studied to distinguish the risk management process in relationship contracting from those risks in projects procured under the more conventional contracting methods. The results indicated that the risks could be better managed via risk sharing rather than risk transfer. Similarly, a simple incentive scheme to encourage a more collaborative approach should be established from the outset of the project.

Keywords: Risk management, relationship contracting, South Australia

1. Risk transfer or risk share?

Traditionally clients try to transfer as much as possible of the risk to non-owner parties [1]. This risk management strategy often fails and results in a construction industry plagued by dispute, time and cost overruns, adversarial relationships and overall poor performance [1, 2].

The Australian Constructors Association recommended a risk embrace approach to target the ill-apportioned risks in construction projects [1]. In such an approach, all parties share both risks and rewards. This joint risk management approach can be facilitated by relationship contracting and its principles [3].

2. Relationship contracting

The term *Relationship Contracting* is used to illustrate delivery systems that concentrate on relationships between participating parties to a construction contract, rather than just on the project-specific requirements [4].

The most important facet of relationship contracting is to enable (or at least aim to enable) all parties to achieve success. Such a 'win-win' approach is achieved by the alignment of the objectives of parties and gainshare/painshare mechanisms. This is a significant departure from the traditional 'win-lose' scenario.

In relationship contracting arrangements, the risks are embraced rather than transferred. All parties share the risks and rewards.

In South Australia, two major public projects that employed relationship contracts were the Adelaide Convention Centre extension (ACC EXT) and the Lyell McEwin Health Service Redevelopment Stage A (LMHS A). Both projects were completed with outstanding performance.

3. Risks involved in the ACC EXT project

This was a large project in terms of size. There were more than 7,000 m2 of column free floor space, over 6,000 cubic metres of concrete were poured on site, some 700 tonnes of structural steel were used in the plaza deck with another 3000 tonnes of steel framing used on the main building.

The time frame of the ACC EXT project was fixed and the budget was very tight. South Australia won the right to host the international wine conference held in the Adelaide Convention Centre in Oct 2001. The set completion date of August 2001 could not be compromised. The extremely short timeframe for delivery meant that the documentation used for the tender was incomplete.

The design of the project was very complex. The facility had to be constructed over operating railway tracks, surrounded by other operating facilities. The disruptions to the surrounding facilities had to be minimized.

The traditional approach (i.e. full design, full documentation, tendering and then construction) could not satisfy the client's requirements to deliver such a complex facility in such a tight schedule. Accordingly, a fast track approach that enabled the design and construction to overlap and be carried out concurrently was adopted. This significantly increased the risk of construction contract disruption and claims [5].

4. How were risks dealt with?

4.1 Pre-contract phase

A very different tendering process was used to choose the contractor for the project.

The process comprised initial short listing, interviews, final short listing, workshops, selection of the preferred tenderer and negotiation for the finalisation of the contract.

The ability of the managing contractor to collaborate with the rest of the project team was allocated a very high priority. Because of the difference with the traditional approach, price played only a small part in the selection process.

All interviewees emphasized that only 'best-for-project' participants should be selected because they could cooperate with other team members to achieve project objectives. Similarly, the contracting parties were clear about their responsibilities in the project and this reduced the risk of possible disputes deriving from misunderstandings about the project objectives and each party's roles.

While the costs of this tendering process were significantly higher than the traditional process, there was endorsement for the introduction of the relationship contracting approach as an investment in the management of long term project risk.

4.2 Contract related issues - incentives

Risks were shared and managed jointly among all participating parties in this project. The commitment from all parties to collectively bear the risks made it easier to deal with them when they arose. When different opinions arose all the parties discussed the various options and, if necessary voted for a final decision.

The contract provided incentives for the managing contractor to be innovative in looking for value added solutions to design and construction and in the management of construction contingency expenditure.

All non-owner parties, i.e. the Managing Contractor, subcontractors or consultants could propose innovations which would achieve cost savings and/or time savings. The client provided final approval for the innovations to proceed and the net benefit was apportioned amongst the client, contractors and consultants.

Many subcontractors proposed innovative ways to improve the project. This resulted in some $2 million in savings and a certain amount of this was returned to the contractors according to the project incentive scheme.

5. Conclusions

The case study of the ACC EXT project found that risks could be better managed via risk sharing rather than risk transfer. Risk sharing creates a true alignment between all parties and the project outcomes. Every party owns the project and is responsible for the actions and results of risk taking. They all qualified for this as they had been selected on the basis of 'best-for-project' approach.

The incentive scheme worked in the ACC EXT project however; it proved to be a challenge for the project team to manage. The issue of how the reward was to be shared between the managing contractor and the subcontractors was never fully resolved during the project. There were different views within the project team on what constituted innovations. This led to debate about whether or not incentive payments were to be made. Accordingly, a simple incentive scheme that encourages a more collaborative approach should be established from the outset of the project. A clear definition of innovation should also be incorporated in the incentive scheme.

References

[1] Australian Constructors Association. (1999) *Relationship contracting: optimising project outcomes*. The Association, Sydney, N.S.W.

[2] Zuo, J. and Ma, Y.F. (2004) Project Culture – A Move Towards Trust, *the QUT Research Week Conference*, July 4 – 5 2005, Brisbane, Australia.

[3] Rahman, M.M. & Kumaraswamy, M.M. (2002) Joint risk management through transitionally efficient relational contracting, *Construction Management and Economics*, Vol. 20, p.45-54.

[4] Quick, R. (2002) Introduction to Alliancing and Relationship Contracting, *the QLS/BAQ Symposium 2002 – Session K, Construction Law*, Queensland, Australia, 02 March 2002.

[5] Department for Administrative and Information Services (2001) *Adelaide Convention Centre Extensions project Completion Report*. unpublished, Adelaide, South Australia.

SECTION II

Executive summaries, W086 Commission

(*edited by E. De Angelis*)

The assessment of sandwich panel durability. Thermo-physical and colour characteristics

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The knowledge of buildings components and systems durability is essential especially in the design phase to prevent risks of degrade and pathologies that often produce considerable waste of resources in phase of exercise. In the circle of a more general research on the durability of the building components, according to the methodology of standard ISO 15686, which involves different Italian Universities, the Research Unit of Palermo is carrying out a study on pitched roofs and particularly on sandwich panel made of two pre-painted galvanized steel skins and connected by a polyurethane foam core. This paper introduces the first results of the research respect to the thermo-physical characteristics (conductivity and thermal resistance) and the analysis of colour measured on unweathered and weathered samples.

Keywords: Sustainability, Durability, Sandwich panel, Thermo-physical characteristics, Colour.

1. Introduction

Italy, despite holding the first places among the industrialized countries in the consumption of energy, has never defined criterions or rules to plan and build with a low energetic consumption.
Only with the Directive 106/89/CE on the construction materials and with the Directive 2002/91/CE on the efficiency of buildings from the energetic point of view, incorporated by D.Lgs 19/08/2005 n.192, some limits on the energetic requirement and on the building components thermal transmittance values have been introduced.
In the circle of a more general research on the durability of the building components, according to the methodology of standard ISO 15686 [1], which involves different Italian Universities, the Research Unit of Palermo is carrying out a study on discontinuous roofing class and particularly on sandwich panel.
The service life is assessed by means of laboratory and outdoor aging tests, which follow some investigations to measure the state of the performance characteristics.

2. Materials and methods

To evaluate the durability, and in particular the state of component's performance characteristics, two type of tests have been conducted:

- not destructive tests: aspect, colour, weight;
- destructive tests: thermo-physical characteristics, mechanical characteristics.

The specimens were directly supplied by the Italian Association of Sandwich Panels Producers (AIPPEG) in two colour:

- bright (White-grey)
- dark (Rosso di Siena)

The aging of samples was done inside a climatic chamber that reproduces the principal climatic agents: rain, sunlight, high and low temperatures, variations of relative humidity. The weathering accelerated cycle, which has a duration of 12 hours and was carried out on the basis of climatic data of Palermo's context, consisted of four phases:

1. Rain
2. Cold
3. Warm dampness
4. Dry heat

In this paper the results of the investigations about the colour analysis and the thermo-physical characteristic after the first 30 and 60 cycles of accelerated aging, are shown.

3. The colour

We evaluated colour and its variations by a colorimeter [2] which use the L*a*b* coordinates and the tristimulus equations of Standard Observer CIE 1976 [3].
In this space, there are three fundamental parameters:

- hue (red, green, blue etc.);
- luminance (the stimulus which goes from black to white);
- chroma (which represents the colour saturation).

We used the colorimeter CHROMA METER CR-400 with Xenon lamp and geometry of illumination and fixed view.
The tristimulus values were calculated with CIELAB recommendations for the 10° supplementary standard colorimetric observer and source D65 [4].

After about twenty months outdoors the colour differences from weathered and unweathered samples were determined.

4. Thermo-physical characteristics

One of the fundamental requisites of the panel sandwich is thermal insulation, for this reason the measure of thermal conductivity of the whole component and of the only polyurethane expanded foam was done.
The standard EN 13165, requires the evaluation of the polyurethane's thermal performances, among them there are conductivity and thermal resistance, that must also be declared in the CE label.
The measures were performed in the laboratory of heat transmission (Responsible Prof. Carlo Giaconia) of DREAM at the University of Palermo.
The apparatus can be used for the measurement of the thermal conductivity in stationary conditions of building materials, according to the standard UNI/CTI 7745. If we know the temperatures around two faces and the heat flow that crosses the specimen it's possible to calculate, through the Fourier formula, the thermal conductivity of a sample with thickness s and surface S.
The measurements were conducted first on the whole sample with coverings, with the purpose of appraising the panel's insulation characteristics and to investigate the experimental problems connected to the execution of a measure on a whole sample (without forgetting that, in this case, thermal insulation also depends on the metal skins and their interfaces with polyurethane).
We have also retained the importance of investigating the behaviour of the only polyurethane foam (using from the heart of every sample two sections with a thickness of 10 mm at distance of 5 mm from the edges). This choice allows us, firstly, to calculate the average arithmetic among two measurements and secondly, to observe possible different values dependent on the position of the polyurethane in comparison to the exposed surface and therefore of the different types of sunlight to which the panel is submitted.

5. Conclusions

The results, even though partial, allow the expression of the first considerations on the time behaviour of the sandwich panel. It was particularly observed that later, almost two years of exposure outdoors, the characteristics of the external covering (pre-painted metal skin) and of the insulating polyurethane core are not very different from the initial values.
On the basis of the Italian D.Lgs. 192/2005 and of directive 91/2002/CE, which foresees the values limit of component transmittance for assuring the thermal insulation of the building, the nature of the material and/or the thickness of the used building components must be taken to consideration.

In particular, it results that:

- the unweathered bright samples have suffered meaningful variations of luminance and they show a tendency to yellowing, which doesn't happen in the dark samples;
- among the artificially weathered samples the tendency to yellowing remains for bright samples and moreover they result meaningful in the variations of colour for dark samples;
- meaningful variations of the conductivity of the polyurethane are not present;
- the measurements on the whole component point out average conductivity increases of 20%. But such values are influenced by the alteration of the model (deformations, detaching etc.);
- the interface metal skin-polyurethane it deserves particular attention which is a critical point in the thermo-physical behaviour of sandwich panel.

References

[1] ISO 15686-1 (2000) Building service life planning- Part 1 General principles, Part 2 Service life prediction principles.

[2] EN 13523-3 (2001) Coil coated metals – Test methods – Part 3: Colour difference – Instrumental comparison.

[3] Oleari C. (1998) Misurare il colore. Spettrofotometria, Fotometria e Colorimetria, Fisiologia e Percezione. Hoeply editore, Milano.

[4] AA.VV. (1994) La comunicazione precisa del colore, Minolta Co., Milano.

Sustainable rehabilitation of rural architecture

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In Italy the first research on rural architecture dates back to the Thirties and Forties as a result of the joint work performed by architects and geographers; such work is still of great interest today in connection to sustainable development and strategies focused on enhancing the territory and landscape. In particular, the approach to analysis developed and experimented by Giuseppe Ciribini is still relevant today and provides the guidelines to current study and research work dealing with rural architecture. The study and knowledge of the reasons underpinning the building approach, building materials and the traditional technical solutions adopted in mountain places is highly instructive: learning from the past to be able to manage the future more competently. The aim of this paper is to highlight how the application of analysis-based methodologies to the study of rural and mountain architecture might help identify different building features and eventual re-occurring pathologies in addition to providing design supporting tools and sustainable recovery tools.

Keywords: sustainability, rural architecture, restoration, maintenance.

1. Introduction

Development of "spontaneous" architecture of the Alpine and Prealpine valleys has followed the centuries-old construction traditions that in one meticulous study, were revealed as being intimately tied to the place, its climatic characteristics and its ability to provide resources.

Since the 1930s, the growing interest in the traditional constructed heritage in Italy has promoted a systematic study and constructive analysis of the rural building industry that are still relevant today that the century-old balance between man, nature and building traditions is directly threatened by new restorations projects. The study and knowledge of the reasons underpinning the building approach, building materials and the traditional technical solutions adopted in mountain places is highly instructive: learning from the past to be able to manage the future more competently.

2. The first studies on the rural architecture

In Italy the first research on rural architecture dates back to the Thirties and Forties as a result of the joint work performed by architects like Giuseppe Pagano [1] and Enrico A. Griffini, geographers like Roberto Biasutti and Giuseppe Nangeroni. In particular, the approach to analysis developed and experimented by Giuseppe Ciribini [3] [4] [5], that is still relevant today and provides the guidelines to current study and research work dealing with rural architecture, are presented here.

The interest for "the vernacular architecture" in those years above all was turned to the historical-evolutionary study of the building typology and the traditional constructive elements to repurpose them, in standardized way, in the new rural buildings. Then, the building knowledge was not finalized to rehabilitation, maintenance and conservation works but to make out the reasons of the traditional technical solutions.

The methodology used for these studies was found on the fundamental role of the survey.

3. The G. Ciribini's studies on mountain architecture

The application of the method of study on the rural architecture developed by Giuseppe Ciribini previewed, preliminary, the classification of the buildings according to typological criteria, with reference to the aspects linked to the human activities and to the materials, chronological criteria and geographic criteria.

The method was set up in phases, as follows [5]:

1) Phase of local and general historical-evolutionary surveying.
2) Investigation about the building elements and critic-statistics surveying.
3) Phase of technical and formal improvement.
4) Phase of normalization.

The methodology to face in systematic way the researches on the rural and mountain architecture has been experienced from the same Ciribini [4] on various mountain territories. With reference to Monte Rosa Valleys, for example, these experimentations has allowed to reconstruct the typological and functional evolution of the house identified as "valsesian type" and to investigate, in particular, the role of some architectonic characterizing and recurrent elements, like the arcades and the loggias, and their relationship to the environments.

The same study puts in evidence as the environmental conditions can strongly influence the building typologies of the mountain houses also within a same valley, anticipating the actual guidelines of research in this field of the built architecture.

4. Application of analysis methodologies

The existing constructed heritage in the rural space, while connoted by unexceptional and popular characteristics in addition to a fundamental and consolidated element of the landscape, represents a cultural and economic resource to preserve and valorise with a view of more general opportunities to respect the environment and landscape protection policies. According to this point of view, starting with research paths already taken and experimented a series of researches has been initiated with a view to developing methodological tools to support the rehabilitation and maintenance work of buildings that typify of the mountain or rural environment.

The methodology is based on an analysis of the structure and its relationship with the environment and conducted on several levels, finalised at recognition of the characterising elements, both with respect to the settlement and with respect to the specific building and technological characteristics and the historic and cultural trajectory that it produced.

In terms of structural materials and technologies, methods of investigation delve into the study of various techniques that characterize the structure being investigated, to open up to more information on the cultural reference material, to explore the motivations for the use of specific materials or singular technological solutions and determining the respective characteristics in terms of durability, maintainability, performance of the original system, as well as the degree of energy consumption and production of potentially polluting substances.

The research methodology has been applied to a few cases-study of rural regions of the Liguria and lower Piedmont and has been adapted to various cases related to specific objectives and extension of the specific region. In particular we refer to a study on the built heritage of the Upper Val Tanaro [6] and to the experiences of research about the G.A.L. Mongioie [7] and G.A.L. Langhe Roero Leader [8] regions, conducted by researchers of the 2th Faculty of Architecture of the Polytechnic of Turin in collaboration with teachers of the School of Architecture of Genoa with the technical advice of architects expert in rehabilitation works. This study represents a significant experiences of application of this methodology to develop a Guides for recovery and maintenance of rural buildings.

5. Conclusions

The researches explained through the analysis of the structure made at diverse levels - on a territorial, a building and a detail level - aims to construct a sufficiently complete and targeted investigative picture of the existing buildings, in order to support the possible alternatives of the rehabilitative project. The research aims to identify the development and experimentation on samples of guidelines, of procedural and technical norms, configured in the form of a "Guide for the maintenance and rehabilitation works" that, on the basis of the experience of acquired knowledge, are able to support and direct the design choices from a perspective of respect for the natural and constructed environment perceived in the broadest sense.

References

[1] Pagano G., Daniel G. (1936) *Architettura rurale italiana*, Quaderni della Triennale, Milano.

[2] Ciribini G. (1942) *Per un metodo nelle ricerche sull'architettura rustica*, Centro nazionale universitario di studi alpini, Edizioni Tecniche Polver, Milano.

[4] Ciribini G. (1943) *La casa rustica nelle valli del Rosa: Valsesia ed alta valle dell'Anza*, Edizioni Montes, Torino.

[5] Ciribini G. (1942) *L'analisi tecnica delle dimore rurali*. Marzorati Editore, Como-Milano.

[6] Bosia D. (2005) *Protection and valorization of Alta Val Tanaro built heritage*. AA.VV., *Rural Architecture in Europe between Tradition and Innovation.* Alinea Editrice, Firenze.

[7] Bosia D., Franco G., Marchiano R., Musso F.S. (2004) *Guida al recupero egli elementi caratterizzanti l'architettura del territorio del G.A.L. Mongioie*. Tipoarte, Bologna.

[8] Bosia D. (2006) *Guida al recupero dell'architettura rurale del G.A.L. Langhe Roero leader*. Blu Edizioni, Torino.

Fiber-cement roofing slates and shingles

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Early in the 1980's, manufacturers started to respond to the market desires for a Class A fire rated steep sloped roofing intensified by fire storms in California where the conventional cedar wood shake roofs were often blamed for the high fire losses experienced. Other manufacturers sought slate like roofs that were lower in cost than natural slate. Both groups tried a variety of materials and cellulose fibers including fibers recovered from newsprint, bundles of wood, and more fibrous or shredded wood to reinforce Portland cement matrixes.
Previously asbestos fiber was used with cement to form very durable asbestos-cement shingles, sidings, and sheets. The use of asbestos was discontinued in the United States for reasons that are outside the scope of this report, but many manufacturers felt they could replace asbestos with other materials and did so with performance warrantees of from 25 to 50 years duration.
The authors have investigated and tested eleven of these fake shakes or slates manufactured by nine manufacturers. Hundreds of roofs have been examined in over 20 states. Some failed before the installation was completed. Few survived past their tenth year of exposure. None of these are currently manufactured in the United States.
We provide data selected from our laboratory tests on thousands of specimens made by nine manufacturers (A through I), identify the reinforcements present, list some of the critical properties such as flexural strength, deflection at break, and water absorption, and the specific failure modes for each product.
The principal recommendation to avoid failures of this kind is to use products that have a substantial history of effective performance in the environment to which they will be used.

Keywords: roofing slates, roofing shakes, performance, durability, application failure

1. Introduction

Many homes were and are lost due to forest or brush fires in California. Some of the losses were blamed on the use of split cedar wood shakes that were, and still are very popular in the western United States. The fire loss blame on cedar shakes may be over stated because no roofing system will influence the outcome when the whole house is engulfed with flames fanned by high winds. Never-the-less, this was perceived as a market opportunity by several manufacturers who quickly responded with wood shake look-alikes made from Portland cement and a variety of fillers and reinforcing fibers. Passing the Class A fire resistance test [1] was a primary requirement The discontinuance of the use of asbestos fibers in the United States caused other manufacturers to seek other reinforcing fibers to replace the fibers in the asbestos-cement shingles. Cellulose fibers recovered from newsprint, ground wood, glass fibers, and plastic sheets were used in many varied combinations, by a number of different processes to produce a product suitable for the roofing market. All of these products were offered to the market with warrantees that ranged up to thirty or fifty years, yet they failed upon exposure to the weather, often in less than ten years. Some failed by breaking and sloughing off the roof before project completion. "Failure" in these cases was defined as when a knowledgeable observer recommends replacement of the roofing.

2. Discussion

The wide-spread presence of any of the following field observations demonstrates system failure.

Cracking of the top coating includes micro-cracking or the start of general deterioration.

Top surface exfoliating is frequently the next step in the deterioration process.

Wide spread cracking through of shingles admits added water into the system, broken shingles can act as a sliding board for workmen on the roof, and the shards can be missiles when they fall from the roof.

Warped or cupped shingles are often the prelude to cracking with or without roof-top traffic, and admit more wind blown rain than was intended by the system. Maintenance of the roofing system and the roof-top equipment is impractical if the roof cannot support foot traffic.

Soft or punky top surfaces invite and encourage water penetration.

Moss or grass growth are not necessarily detrimental to the roofing, but the presence of these plants shows the long term presence of water – which is damaging to the roofing materials.

Separation of the layers is the principal failure mode of products made by pressing together matrix layers. The separation is due to water intrusion and swelling of the lamina.

Many of the producers attempt avoid problems by limiting the application of these fiber-cement products to geographical areas that see little-or-few freeze-thaw cycles. This is of some assistance, but the producers fail to realize that wet-dry cycles (without freeze-thaw) will do similar damage to materials.

Product 1 - Laboratory data reveals that these shakes have the lowest density of this group of man-made products, the highest water absorption (46 to 64 percent), and next to the lowest flexural strength. The 1.5 kg (3.4 lb) handleability index shows they are more brittle or friable than natural slate which has a 3.7 kg (8.2 lb) index.

Note: The handleability index is calculated by: $U = (0.5P\Delta)/t$; where U is the index, P is the breaking load, Δ is the ultimate deflection at a 254mm span, and t is the thickness of the specimen.

Products 2 & 3 - Laboratory tests showed these products to have a similar density (1.4 g/cc) and flexural strengths below the minimum saturated modulus of rupture (5.5 MPa) listed in ASTM International standard [2].

Product 4 - Producer "D" manufactured outside the United States and details of the manufacturing process are not known. These products are characterized by a very strong – almost baked enamel – top coating.. The products were removed from the market before we obtained samples for examination

Product 5 - These shingles became embrittled – probably due to carbonation of the free alkalis present – and frequently delaminated after weathering. The 1.9 kg (4.2 lb) handleability index illustrates that they are more friable than natural slate.

Product 6 - The principal negative field observation is a constant tendency for the bottom edges of the shakes to cup upward. Many broken shakes were recorded. Any roof-top traffic caused the shakes to crack – often near the fasteners – where the crack is covered by the higher row of shakes

Product 7- The average water absorption is 35 to 51 percent of the dry weight of the shingles. We found that weathered faces absorbed water up to16 times faster than unexposed surfaces. Wetting and drying of the fibers cycles the fiber swelling and shrinking. In addition, soluble alkali salts migrate into the fibers and are converted to calcium carbonate – the well known process of carbonation that embrittles the shingle.

Product 8 - Laboratory testing showed a significant decrease in flexural strength, deflection at break, and handleability index in the samples that had been exposed to the weather when they were compared to the unexposed samples. The deflection at break was less than the thickness of the nail heads typically used to install these products.

Products 9 & 10 - Unlike some of the other fiber-cement shakes, the top surfaces are dense and relatively intact. We saw the exposed shakes cup upward on every roof. Almost any that were laying flat were broken. These broken shakes channeled rain into the system, onto the secondary water rejection felt to erode it and to eventually leak into the building. Warped shakes are prone to break under foot traffic – making rooftop maintenance impractical since any traffic would add to the broken shakes

Product 11 - Product 11 was unique in that it was prepared in layers to make up the tapered shake. The bottom layer was a 0.08 mm (0.003 in.) polyethylene terephthlate membrane with random directional fibers, a plant fiber filled (probably wood or paper) and aggregate filled Portland cement matrix, incorporating a 0.33 mm (0.013 in.) thick isotactic polypropylene mesh with a square 12 mm (0.5 in.) pattern, topped with a dense cemeticious pigmented material.

3. Conclusions

Over the ten years covered by this report, there have been many instances when even casual checking would have shown the dangers inherent in these formulations. Perhaps the new manufacturers felt they had some magic to overcome the fundamental problems illustrated, but such optimism is short sighted. The facts remain:

- There are no test methods of programs that accurately predict the durability of a roofing system.
- Only the historical durability of a system in a similar environment is an appropriate indicator of performance
- Long term warranties may be the worst indicator of durability.

References

[1] (1996) *E 108 - Standard Test Methods for Fire Tests of Roof Coverings,* 2005 Annual Book of ASTM International Standards, Vol. 04.07.

[2] Gumpertz. W.H., Condren, S.J., (1998), The Deteriorating Artificial Slate, *Roofing Research and Standards Development, 4th Volume, ASTM STP 1349,* 93-111.

[3] (1991) *C 1185 Standard Test Methods for Sampling and Testing Non-Asbestos Fiber-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards,* 2005 Annual Book of ASTM Int. Stand., Vol. 04.05.

[4] Cash C.G., (1995) Performance Failure of Organic Fiber Reinforced Cement Roofing Shingles, *4th International Masonry Conference,* The British Masonry Society.

Rain on building façades

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In this paper we will address the question 'Are there differences among the mechanisms of deterioration due to rain in traditional or contemporary building façades?' First some principles of driving rain on buildings are presented using Computational fluid dynamics (CFD) simulations. Then, driving rain control by the presence of façade modulation by cornices or roof overhangs with appropriate detailing (drips) in traditional facades is analyzed. In a third part, two examples of problems with contemporary façades, i.e. staining from horizontal surfaces without drips and the degradation due to rain penetration in a face-seal façade, are reported.

Keywords: building façade, wind-driven rain, decay phenomena, cornice, curtain wall

1. Introduction

Architects and constructors have been aware of the problems related to rain deposition on building façades and have developed strategies to shelter façades, shed running down water and prevent rain penetration. In addition to the use of efficient materials and techniques, they designed particular modulation and detailing of the façade to decrease the driving rain load on the facade. These modulations of the traditional façade became an intrinsic part of "traditional" architecture. The different developments of architecture along the 20th century have led to the partial or complete removal of rain water shedding elements from the façade. An example of new façade type that resulted from the search for transparency and lightness of Modern architecture is the curtain wall.

2. General principles of rain deposition on façades

Before looking at the role of façade modulation and details on controlling driving rain, it is necessary to understand how rain strikes different façades. Three categories of methods exist to investigate how much driving rain is deposited on building facades [1]: 1) measurements with driving rain gauges; 2) semi-empirical relations such as those employed in the European Standard Draft for driving rain assessment [2] and numerical methods based on Computational Fluid Dynamics (CFD) [3-4]. CFD studies are given below looking simply at deposition of driving rain, and disregarding absorption and run-off. Let us first analyze the validity of the common statement "the higher a building, the more driving rain it will receive". Therefore we simulate driving rain deposition on buildings with different height. Modulation of the wall or detailing is not present.

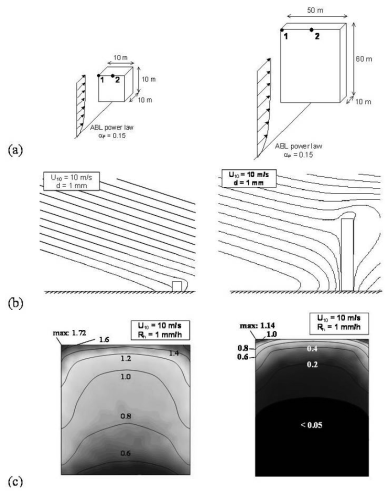

Figure 1. CFD simulation results of driving rain on a low-rise building and a high-rise building slab

Figure 1 presents results of calculated rain trajectories and driving rain deposition patterns on the windward facade of two different buildings: a low-rise cubic building and a high-rise building slab [4]. The results are given for a rainfall intensity of 1 mm/h. The wetting patterns on both buildings indicate that the top edge and top corners of the facade are most exposed to driving rain, and that significantly less driving rain hits the lower parts of the facade. Similar results are obtained for other rainfall intensities [4]. When comparing the wetting patterns of both buildings in Figure 1, significant differences are observed. Under the same meteorological conditions, the high-rise wide building facade receives much less driving rain that the low-rise building facade. This indicates that the common statement “the higher a building, the more driving rain it will receive” is not necessarily true. In fact, each building protects itself to some extent from driving rain impact. This phenomenon is called the “wind-blocking effect” [4] and it becomes more important as the size (width and height) of the building increases. A high and wide building presents a larger obstruction to the oncoming wind flow and therefore slows down the wind speed in front of it. Because of this, the driving force of driving rain is reduced and the raindrop trajectories start bending away from the facade. This effect not only causes a lower driving rain exposure at the top of the building; it is also responsible for the fact that the lower part of the building remains relatively dry. These observations appear to be in contrast to the general notion that the driving rain exposure at the top of a building increases with the building height.

3. Modulation of traditional façades and detailing to shelter and deflect rain

Since top edges of facades are most exposed to driving rain, appropriate facade detailing at these positions is very important. Figure 2 shows calculated raindrop trajectories impinging on a façade with and without roof overhang.

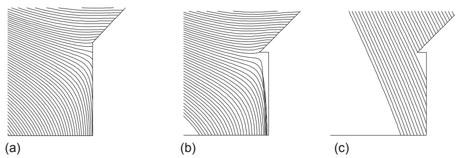

Figure 2. Raindrop trajectories on the facade of a building with and without roof overhang

Differences between cornices are usually due to the sinuosity of the moulding motifs and the dimensions of their projection. The variations of these two aspects over the centuries have transformed the cornice from an architectonic element into a decoration of the façade. The misunderstanding that the cornice had only a decorative function, disregarding its rain shedding function, led to the almost total vanishing of this architectural feature in Modern and Contemporary architecture. Besides the sheltering effect of cornices and roof overhangs, the correct detailing of these features is essential. The need of a proper design and detailing of the cornice is illustrated by the example of degradation of cornices and facades of old buildings located along the coast of Sicily.

4. Rain on modern façades without moisture buffering

With regard to the action of the rain on the modern façade, it can be noted that the lack of shedding elements, such as those that are able to retard the deterioration of the façade in the traditional architecture led to a concentration of decay manifestations at joints and junctions of envelope components. The main failure mode due to rain in non-moisture buffering walls is water penetration. Since the first use of curtain walls, it became obvious that the lack of moisture buffering of the façade resulted in more rain water run-off and in an increased risk of rain penetration, especially at not projected junctions. Despite continuous improvements and technological developments, aluminium and glass curtain wall systems have been shown to be very susceptible to design shortcomings and risk of rain leakage.

5. Discussion

The modulation and detailing of traditional façades have been important measures to reduce the driving rain load. Walls of traditional architecture made of capillary active materials such as stone, brick and mortar can remain wet without rapid deterioration. On the contrary water infiltration in metal and glass façade systems, is one of the main durability problems of modern architecture buildings. The façades of such building are found to be prone to defects notwithstanding their complex technologies and ingenious details. So, what kind of solutions do designers and contractors have to develop to prevent water penetration in the contemporary façades?

References

[1] Blocken B, Carmeliet J. (2004). A review of wind-driven rain research in building science. Journal of Wind Engineering and Industrial Aerodynamics 92(13): 1079-1130.

[2] CEN/TC89. (2002). Hygrothermal performance of buildings – Climatic data – Part 3: Calculation of a driving rain index for vertical surfaces from hourly wind and rain data. prEN ISO 15927-3, Standard under approval, 2002.

[3] Choi ECC. (1994). Determination of wind-driven rain intensity on building faces. Journal of Wind Engineering and Industrial Aerodynamics 51: 55-69.

[4] Blocken B, Carmeliet J. (2006). The influence of the wind-blocking effect by a building on its wind-driven rain exposure. Journal of Wind Engineering and Industrial Aerodynamics 94(2): 101-127

A case of pathology from damp

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The paper illustrates the manifested degradation in a nineteenth-century rural building recently recovered. Through the iter that goes from the documentation of the existing state, to the project and the execution of the works, it will be focused on a degradation of the external surface due to manifested damp after around a year from the completion of the works. Tthe phenomenon has been monitored and studied. The paper concludes with the phase regarding the direct inspection, the adoption of fit solutions of vertical obstruction, the removal of plasters and the use of fit products furnished by the market.

Keywords: Building failure, damp, diagnostic, solutions

1. Introduction

The “red house” is a rural building located inside the Orleans’ Park. The buiding, whose construction age probably goes back to the last years of the XVIII century, was born as “stable” and its vocation remained up to 1940, tied to agricultural activities practiced in the property. From 1940, date of requisition, to 1950, date of sale of the park to the University, and in the next years, the “red house” knew the period of maximum decay tied before to the abandonment and then to the unauthorized occupation. 1993 is the year of the building revival, after recovery, to kindergarten for university employees’ children. The project was delivered in 1994. The building works were directed by the same designer, handed on 30.05.02 and finished on 26.11.03. The recovery project restores the original symmetry of the building demolishing the unauthorized addictions. The new works, perfectly distinguishable and removable, consist in a steel, wooden and polypropylene passage and crossing the court and an iron and round off marble staircase bringing from the entry to the superior rooms.

2. The manifestation of phenomenon

On May 2004, after almost six months from the completion of the works on November 2003, some damp-stains appeared in the South-East corner, extending around two walls. Because the pathologies weren’t connected to particular rains, but increasing with the increase of temperature due to summer, we decided to study the possible causes as to remove them before repairing the fronts with plaster.

The phases of analysis concerned:

a) the pre-diagnosis
- historical-technological investigation of building;
- environmental investigation;

b) the diagnosis
- relief and representation of the phenomenon;
- instrumental investigations on site and in laboratory (partially destructive and not destructive);

c) the prognosis
- interpretation of the collected data;
- identification of the initial causes of phenomenon;

d) the intervention.

3. The pre-diagnosis

Historical-technological investigation - For what concerns the state of fact on 2002, in the N-E and S-E prospectuses, consistent lacks of plaster can be observed in the band under 2 meters being markedly distinguishable in comparison to the serious and diffused degradation of both the fronts. The undamaged part of the N-O prospectus shows traces of climb ascending damp and some separations of plaster. The recovery project approaches the use of local constructive tradition materials and techniques to new functional and structural solutions. particularly, the N-O annex of the building, partially collapsed, has been reconstructed with carrying masonry in limestone blocks as the existing masonries, tied up with lime mortar; a riddle of r.c. has been cast on the existing continuous foundations along the whole N-O front, also realized in blocks of tufo, sets 90 cm under the plane of site; part of the existing masonries have been consolidated with wire net and concrete casting. While the first level attics are realized in laterocement with gap, the flooring of the courtyards is realized with blocks of stone recovered by the various rooms and set on ground floor loose stone foundation. The whole building has been covered with a plaster of cement mortar and with a red tonachina and industrially produced with traditional materials. The building has been protected from damp through the realization of aired attics whose gap had to be connected with an aired burrow along the perimeter as to protect the whole building. Such burrow could not be realized because it was preferred to complete the building structure with the available funds.

4. The diagnosis

Investigation of the border conditions of the site – Notable influence on the revelation of degradation has had the absent external arrangement of the immediate nearness to the house. The front S-E is set near to an uncultivated ground in direct contact with the foundations. The front S-O faces on an external little court was set and during the recent works an around 25 m deep well was found and detected. The datum is particularly interesting because the considerable depth of the water level is such to exclude that ascending damp originates from groundwater.

Relief and representation of the phenomenon – Photographic documentations and following graphic representations have been done in different dates, two months distant, beginning on May 2004, date of the first demonstration, up to April 2005, considered date for the stabilization of the phenomenon. It was possible to observe as the expansion of the phenomenon was accompanied by a worsening: first chromatic alterations changed in some cases into efflorescences and in next separations of the plaster. Afterwards stains and isolated efflorescences on the N-E prospectus appeared, but in the right side set to an around 2,50 m height.

Instrumental investigations on site and in laboratory The realized instrumental tests, are the following:

- Ponder test and chemical analysis
- Thermography
- Electric tomography
- Measures of superficial damp with hydrometer

5. The prognosis

Interpretation of the picked data – The observation of degradations conformation of the building before the intervention shows a marked separation in a band of around two meters from the plan of stamping, of the principal prospectus. The stricken zones mostly seem to fit with those actual. The visual observation of the actual conformation of the decay allows still today to suppose that the phenomenon is to tie to the presence of ascending damp, although due to the depth of the fault, the problem is attributed to the contact of the embankment with the foundation rather than to ascending damp from subsoil. The presence of white microcrystalline efflorescences mean the already verified sulfates and chlorides presence and the separation of plaster finish allows to suppose an incompatibility between this one and the underlying layer. The ponder test and chemical analysis have shown the presence of salts in the masonries, particularly sulfates and chlorides. Few clear appears, instead, the total absence of nitrates, typically diffused in agricultural lands.

Identification of the causes that has baited the phenomenon - The agreement between visual observation and experimental data confirms the thesis of ascending damp by contact, for less than the clear phenomenons tied to defects of water disposal system..

6. The intervention

We proceeded with two different interventions. The first facing the elimination of the infiltration for direct contact between masonry of foundation and ground, water soaked, through the realization of an aired burrow on the S-E and N-E fronts, mostly interested by the phenomenon. As to allow the correct airing inside the burrow some pvc channels inside masonry have been installed, communicating with the outside at different heights to produce inside the burrow, through a difference of pressure, a movement of controllable air from the outside; the burrow has finally been covered with a bituminous scabbard. To complete the intervention, a draining ground floor loose stone foundation has been realized with shapeless stones of big dimensions for the whole area interested by the external arrangement of the pertinent ground of the building. We proceeded therefore to the removal for an around 1 m height of the existing plaster reaching to the raw masonry, left to the air for about two months, and put on in work an iper dehumidifiing system, constituted by four layers .

References

[1] Longo C., Tortorici M. (2003) *Il parco D'Orleans. La cultura del giardino siciliano d'età contemporanea. Officine grafiche riunite, Palermo*.

[2] Di Matteo S. (1983) *Il Palazzo D'Orleans e il suo parco. Edizioni Giada, Palermo*.

Roofing technologies evolution through pathologies investigation

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The paper present a condensed history of contemporary roofing (about the last 50 years) in Europe, with a special reference to Italian construction sector. The Italian industry of roofing products has been – and probably still is – world leader, excelling in product and process innovation, in low-cost waterproofing products like polymer modified bituminous membranes. Building Pathologist is strongly interested in this product innovation process, because its success is based on the investigation and quickly understanding of modes of failures. The following Executive Summary, just shows and briefly comments some images related to the fundamental degradation mechanisms of their components and the principal modes of failures of waterproofed flat roofs, that are more deeply analyzed and discussed in the paper.

Keywords: roofing, waterproof membrane, building pathology, learning from errors.

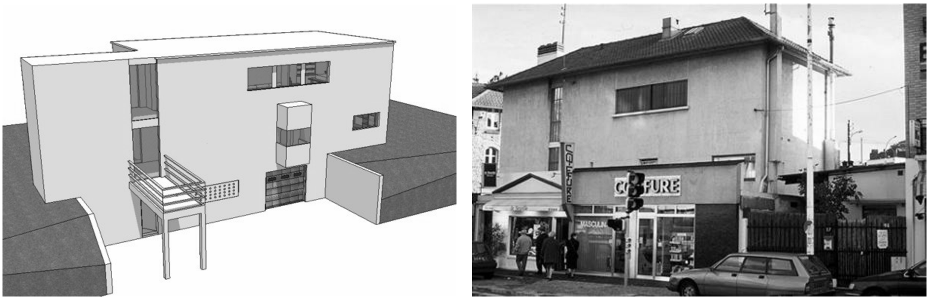

Fig. 1. Flat roofs and terraces are critical architectural choices from the hanging Babylon gardens. The pictures show the Le Corbusier villa Vaucresson, dated 1922 and its later “refurbished” version, after probable long series of water infiltrations and maintenance works through flat roof. At that time, waterproofing technology was still based on the application of thick asphalt layers, not easily turned up on walls and parapets, or on built-up bituminous roofing membranes (many fiber layers plus hot melted asphalt). Both systems were fragile at temperatures below 10°C, just few months after its application, and suffered any cracking or movement of the substrate (images from: http://www.pushpullbar.com/forums/)

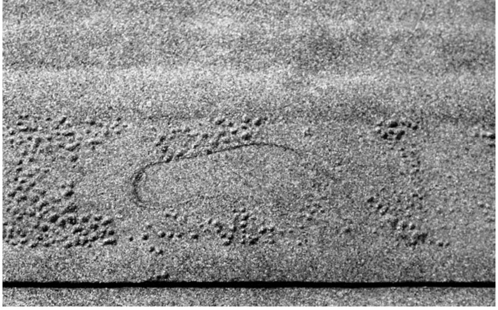

Fig. 2. Low flexibility at low temperatures was not the only problem of asphalts as well as the prefabricated membrane shown in the picture: these first bituminous sheets were made with oxidized natural bitumen or coal tars, stabilized with accurately mixed fillers. Fillered oxidized bitumen membranes were much better than natural asphalts and much easier applied than built up roofs, but they still suffered heat: their flexibility were quickly reduced and their melting temperature were still too low. The membrane on the left shows a diffuse blistering and a foot print. Blistering is caused by its water absorbivity, footprints by its low melting temperature.

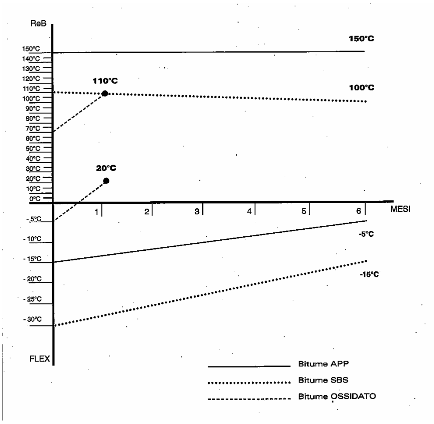

Fig. 3. New performances were asked to roofs (thermal insulation, weight reduction) and new products were introduced. Thinner waterproofing layers were no more applied on stable concrete slabs (see also fig. 4) and fixed and protected by thick terrazzo paving. They were applied on discontinuous and instable layer of insulation panels (expanded resins or fiber) and protected only by a metallic film or a thin crushed stone layer. On the top of these roofs, bituminous membranes were subjected to much higher thermal cycles. Thermal cycles was the cause of thermal weathering and of reversible and irreversible dimensional change. Highly performing waterproofing products were needed, to overcome these problems, an new products came: polymer modified bitumen mixes on fiberglass felts were much more heat and cold resistant as well as stable against dimensional variation and thermal weathering.

Fig. 4/7. Thermal insulation technologies (figg. 4,6,7: fiberboards; fig.5: polystirene panels) and wider used new structural systems (metallic decks) were the cause of new hazards: wind resistance of the roofing system were not easily assured at deck-insulation interface (figg. 4-5) as well as at insulation-membrane interface (figg. 5-7). The first mode of failure (fig.3) urged for higher tensile transverse resistance of waterproofing membrane. The second (both fig. 4 and 5) forced specifiers to remember mechanical fixings or a reliable gluing of insulating panels on the substrate. The third (fig.6) taught that mechanical fixings had to be improved to avoid membrane puncturing and the fourth (fig.7) remembered that also insulating panels were subjected to wind actions and needed to assure a basic tensile resistance.

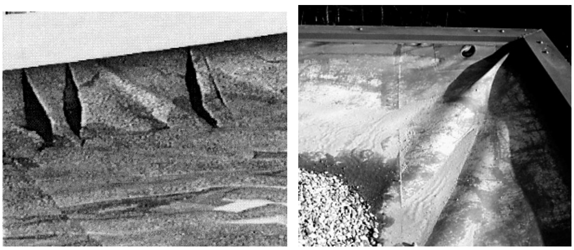

Fig 8/9. Shrinkage was already a problem for prefabricated bituminous membranes too, expecially when, to improve their transverse resistance, they were reinforced with heavy synthetic felts instead of glass fibers. The first PVC membranes were added with plasticizer unstable, against the heavy weathering stresses on roof top, and their shrinkage was able to pull away membranes from parapets in few years.

The story continues on the paper ...

Technologies and non-structural failure modes of below-grade building envelopes

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Below-grade building envelopes are obviously different from above-grade ones. It is not only because of their contact with soil and water and construction technologies to be adopted, but also because of the high risk of failures in water and air tightness. The paper tries to present a complete list of requirements to be satisfy in their realization, gives a panoramic view of the various waterproofing strategies and technologies and lists some of their principal modes of failure.

Keywords: Waterproofing, Below-Grade Buildings, Envelope, Leaks, Failure modes.

1. Below-grade envelopes

The performances required to below-grade envelope systems are quite few, compared to above-grade ones, and the most critical one is its tightness:

– Liquid water infiltration and transfer through te envelope must be avoided

– The diffusion of water vapor and other gases through its joints and through the porous materials it is made of must be carefully controlled

The design and the realization of the underground envelope of a buildings ask for particular care, because, once a failure occurs, maintenance and inspection operations are very difficult, at soil side, and because underground construction operations are more difficult. The importance of this care is not so well practiced, because underground constructions culture is relatively new and not so much diffused as, for example, roofing knowledge.

The effects of water infiltration can be avoided in three basic ways:

a. keeping (draining) water away from the soil near by the envelope

b. draining away infiltrated water (with cavity-walls and cavity floor slabs drains);

c. realizing a low permeability layer outside or inside the envelope

d. using low permeability envelope components well sealed among themselves

Choice among these strategies depends on aquifer deepness and underground water currents, soil permeability and local climate, as well as entity of the possible damages induced by infiltrations and scheduling needs and cost opportunities. The first is the "water management" option ([1] [2]), the second is a sort of "water deactivating" choice, both rarely adopted alone, the last two "water opposing" options, based on the realization of low permeability layers (outside:= "positive side" or inside:= "negative side") or of low permeability envelope components, jointed with opportune seals.

Low permeability layer technologies are the most diffused and can be classified as [4]:

1. Cementitious systems
2. Fluid-applied membranes
3. Sheet membrane systems
4. Clay systems

The choice among them depends on application needs and opportunities offered (which side, retaining wall technologies adopted and other construction choices) and weathering resistance requested.

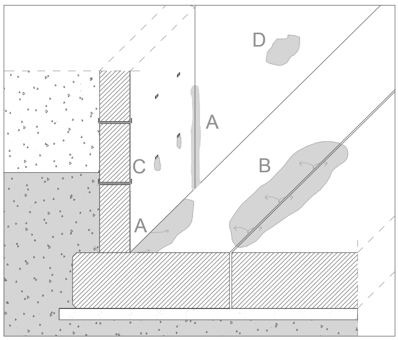

Figure 1. Infiltrations through below-grade walls and slabs. Water spots usually appears where there are construction joints (A, B) or where there are inadequate retaining ties (C) are used or cracks (D).

2. Below-grade envelope failures

Modes of failure of below-grade envelopes are either related to water infiltration or to water vapor and other gas indoor concentrations or both. These failures are caused:

– By unexpected or underestimated water pressure (or just presence) or gas concentration in the soil
– By insufficient envelope tightness against expected or real water pressure or gas concentration
– By the decay or damaging of low water/air permeability layers or components or joints

For what concerns unexpected water pressure, this happens quite often, every time soil characteristics and rain intensity let drained water temporarily accumulate on low permeability soil layers.

Moreover, aquifer water is often underestimated as it can seasonally change its height because of rain intensity, underground currents and industrial or urban water needs.

For what concerns water vapor concentration, soil rarely don't contain water at all, during the whole year. Much less diffused, on the contrary is the knowledge about radon risk. A high air permeability of the below-grade envelope, nevertheless, is always a design or construction error and non-waterproofed underground structures should at least have reasonably sealed holes and joints among components.

When envelope tightness relies on a layer, it can be canceled by application errors (for example, welding defects or overlapping errors) or damaged during earth movement or underground service construction or other defects. When it relies on thick components and their sealing, infiltration of liquid water or just humidity can be induced by unexpected cracking of the first or by sealing errors or sealing damages.

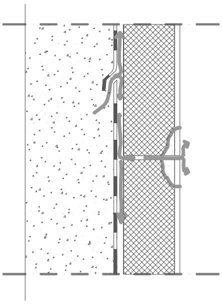

Figure 2. Capillary infiltrations through defective or damaged damp/water-proof positive side layer. If the layer is not well adherent to the wall, water can move between the two and appear far from the "hole".

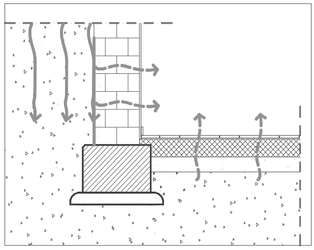

Figure 3. Water vapour or other gas infiltration through walls and slabs and their joints.

References

[1] Henshell J., (2000), *The Manual of Below-Grade Waterproofing Systems*, Wiley.

[2] Rose W.B. (2005), *Water in Buildings. An Architect's Guide to Moisture and Mold*, Wiley.

[3] Kubal M.T. (1993), *Water-proofing the Building Envelope*, McGraw-Hill

[4] Kubal, M. T. (2000), *Construction Waterproofing Handbook*, McGraw-Hill

[5] Cusmano G., Patri G. (2003), *La progettazione di opere edili nel sottosuolo*, Il Sole24 Ore-Pirola.

[6] Cusmano G., Brambilla C.., (2006) *Progettare e realizzare i parcheggi pubblici e privati*, Maggioli.

[7] Shohet I.M., Galil I., (2005) "Decision Support System for Waterproofing of Below-Grade Structures", in *Computer-Aided Civil and Infrastructure Engineering*, N.20 p.206–220

[8] Harrison H.W., Trotman P.M. (2002), *BRE Building Elements – Foundations, basements and External Works*, BRE.

[9] Sanders C., Trotman P.M., Harrison H.W. (2004), *Understanding Dampness*, BRE.

Integration of installations on facades and consequent deterioration

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This report begins with considerations on the damage caused on the surface layer of outer walls of buildings by the installation of technological systems and utility networks. The aim of this study is to emphasize the relationship between such additions and the damage they can cause to reduce the formal/architectural deterioration, to limit the physical damage, to enable the systems and networks to be included already at the design stage, enabling a scheduled maintenance program for the facade with a view to its conservation in use.

Keywords: facades, surface layer, deterioration, utility networks

1. Introduction

The components of technological networks have become an inescapable part of our urban habitat. When the attachment of such installations to the facades of buildings is not governed by specific regulations (other than those relating to safety), they can often cause both physical and formal damage to the layers of plaster and paintwork, and this damage may propagate and ultimately extend to the load-bearing layers of the masonry, and to the various finishing elements with which the installations are related. Hence the need to consider design solutions that enable an integrated installation of these service networks, solutions decided jointly with the service providers. It is also essential, right from the design stage, to study methods for a building's conservation in use that takes each building's specific problems into account.

2. The facade as a set of constituent, integrated and added technical elements

The facade of a building forms a set consisting of *constituent technical elements,* i.e. of a number of technological building units, classifiable according to the Italian standard UNI 8290/81 [1], such as perimeter walls, and of *integrated technical elements,* i.e. those belonging to the building but comprising different technological units, such as gutters and drainpipes, and outside mains gas piping, etc., all of which may be installed on the building's facade. In addition to the above, the facade may be used to attach certain technical elements defined as *added,* in that they do not belong to the owner of the building, but are installed thereon. Concerning the design of elements integrated with the facade, it is up to the designer and owner to verify their compatibility with current legal requirements, and it is the responsibility of the designer to suggest a suitable solution. The Local Authority's regulations on advertising in the municipality of Venice, for instance, lay down precise requirements for the attachment of name plates, doorbells, sunshades, etc., establishing restrictions on their position, the materials of which they may or may not be made, the means of their attachment, and so on.

3. Overhead technological networks attached to building facades: added elements as a cause of deterioration

The above-mentioned provisions are included in various other building regulations too, but are not considered as binding for companies distributing technological services, which generally have their own regulations containing specific methods for the delivery and installation of elements needed to provide their services, and this information is included in the agreements they stipulate with users/customers.A particular type of installation for technological networks in the urban context is called "installation on masonry" and specifically relates to power supply lines, public lighting lines and landlines telephone wires [2]. There are basically two types of installation: with cables attached directly to the building and with cables suspended between one building and another. In both cases, the fixtures are attached using expansion bolts set into the facade using methods that often fail to take the technical specificity of the existing surface layer into due account.

4. Deterioration of a building's "physiognomy"

The facade of a building reveals its real identity. It provides information on when and how it was built, the methods and materials that went into its making, and how time has taken its toll, the characteristics of its inhabitants, how maintenance has been done, and so on. It also tells us, in particular, about the quality of the urban context managed by the public administration. In recent years, various town planning tools have been developed and adopted, e.g. color schemes, urban rehabilitation plans and street lighting plans, with a view to giving added value to towns, and especially to historical city centers. This intense regulatory activity has failed, however, to focus adequately on the problems of how to make and preserve the improvements envisaged in the various measures considered in such plans, because it has failed to identify the wear and tear that can severely affect the appearance of a building's facade. What we are talking about here is the type of deterioration that results from an unsuitable design of a building's constituent elements (gutters, door and window fittings, etc.) and integrated elements (drainpipes, signs, nameplates, outside lighting, etc.), but also and above all from the presence of those added elements (public lighting appliances, public utility networks for providing electricity, landline telephone lines, and so on), which can have a severely harmful impact on the present and future aesthetics of the facade.

The damage caused by electric and TLC lines is of two types, i.e. "physical damage" and "aesthetic damage". The action of natural agents already gives rise to a natural deterioration of the surface layer but a good deal of further damage is caused by the installation methods and positioning of the elements used to attach electric and telephone lines to the walls of the building. The negative impact on the building's appearance is determined by the improper positioning of the cables in relation to the layout of the facade, heedless of the way in which their presence disrupts its formal balance. A horizontal line inserted halfway up the building cuts the facade in two and severely interferes with the balance of its composition. When this line is not even straight and clearly defined, but a muddle of coils and hanging cables, variously bunched together, the dignity of the whole facade is at stake.

5. Installing added elements with a view to conservation in use

Saying that it is essential to arrive at an integrated management of the wiring needed for utilities means that simply assuring the safety of these public services is not enough: in our opinion, this goal must be considered in combination with the building's "conservation in use". This term is used to mean a process, i.e. a structured set of activities, designed both to preserve the reliability features established at the design stage and achieved at the time of the building's construction, and to adapt the building to needs deriving from new legislation or changes in the usage of the building, while also optimizing the costs of the building's management. This process can be organized into three fundamental stages: understanding the building; formulating an opinion on its state of consistency and its capacity to meet the user's needs; and defining which maintenance measures to undertake [5]. To be more specific, in-depth investigations are needed for a thorough understanding of the problems relating to the public utility networks, their installation and the preservation both of said installation and of the building to which they are attached. This demands an analysis into the environmental context and a knowledge of the natural and artificial stresses induced by the agents. The method to adopt in the design stages is that of the requirement approach, i.e. to establish the user's needs in detail, identifying requirements and assessing performance in use. This approach also enables the formulation of specific technical rules which have to be shared by the service provider and the designer.

6. Conclusions

The aim of this paper is to focus the attention of the numerous institutional, public and private parties taking action on this urban space, in the hope that they will find a shared solution and coordinate measures to achieve a dual goal, i.e. to improve the technological and formal quality of our buildings' facades and to contain the cost of said measures by adequately planning and coordinating the related works.

References

[1] UNI 8290/81 Edilizia residenziale - Sistema tecnologico - Classificazione e Terminologia

[2] Tramarin P., 2002 Tesi di laurea: *Reti tecnologiche e degrado in ambito urbano*. Relatori: Emma Dal Zio, Piero Michieletto , IUAV

[5] E. Dal Zio, R. Paparella, F. Vergine (1999) *An instrument for use in building management: the handbook of the conservation in service of a building.* Proceedings of CIB Symposium 99, dr M. P. Nicholson Editor, Nottingham, 1999, 135-145.

The importance of a pathology catalogue for diagnosis: the example of tile-coated façades

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Portugal has a long tradition of applying ceramic tile to façades with excellent results. However, recent years have seen a considerable increase in pathologies. Many of the failures have been due to the hygrothermal conditions to which the façades are exposed. In this paper we present the results of an experimental study related to the influence of hygrothermal action on the adhesion failure of ceramic wall tiles. Building physics is an important design instrument, but available knowledge is not always used to solve and prevent Building Pathology. In relation to this, the Building Pathology Study Group – PATORREB, coordinated by the Faculdade de Engenharia da Universidade do Porto's Building Physics Laboratory (LFC, FEUP), has created the Web site www.patorreb.com where a Pathology Catalogue compiled by various Portuguese universities, has been posted. The Catalogue consists of a set of Pathology Reports that contain a description of the problem, the diagnostic methods used, the definition of the main causes and possible solutions for repair.

Keywords: Pathology, Façades, Ceramic Tile Coating, Hygrothermal Behaviour.

1. What can affect ceramic facade tiling performance?

As the constructive process is so complex, it is never easy to reconcile the many demands that construction elements have to satisfy. In the last few decades, however, the industrialization of construction has made it unfeasible to validate solutions experimentally, and this has meant that the durability of many solutions has been far from what was expected. The lightening of structures and the masonry that supports façades' coatings, plus the inadequate treatment of thermal bridges, from the point of view of stability, and the failure keep information on how the construction was executed, all serve to explain many of the pathologies observed in façades with ceramic tile coatings.

2. Influence of hygrotherm action on adhesion failure of ceramic wall tiles

2.1 Experimental study

Adhesive performance is usually evaluated in the initial period. Knowledge of the adhesive's characteristics at the initial moment is essential for its classification and marking. This initial knowledge, however, does not reveal performance during the adhesive's service life. To show the variation in the cementitious adhesives' performance during their service life, based on the analyses of accelerated aging test results, and to establish long-term criteria for selecting the most suitable adhesives for external ceramic wall tiling systems, we submitted samples to accelerated aging cycles (temperature, moisture, relative humidity and radiation). The results obtained show a significant decline in tensile adhesion strength.

2.2 Model to forecast the service life

It is essential to perform tests at the natural aging station after longer periods and at specific times (every year, for example) to establish the relation between the two tests. By performing two types of tests, in situ and in the laboratory, it is possible to establish a model to forecast the service life of this type of product as shown by the following graphic (Figure 1).

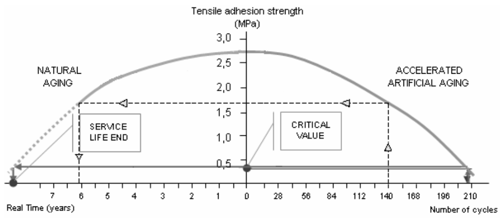

Figure 1. Correlation between the number of test cycles of accelerated artificial aging and the real time of natural exposure – Forecasting model.

3. Building Physics and Pathology

Although building physics is an important instrument for dimensioning and design, the available knowledge is nonetheless not always used, which serves to explain many of the observed pathologies.

Understanding a problem requires knowing how materials and components perform, and it is essential to design the most appropriate solutions from a technological point of view. We consider that the available information on cases of building pathology should at least be used to avoid the same problems recurring. Recording the errors, analyzing their causes, and disseminating this information, are procedures fundamental to understanding the most frequently occurring pathologies and preventing problems.

4. Pathology Catalogue www.patorreb.com

4.1 Building Pathology Study Group-PATORREB

We fell it is very important to systematise the available knowledge, especially pathology studies. The Building Pathology Study Group – PATORREB has therefore created an Internet (www.patorreb.com) Web site –, where the Pathology Reports prepared by the various participating universities are posted and disseminated. The site has been running since June 2004, and has already published 65 Pathology Reports.

4.2 Structure and description of the site

The site is essentially devoted to disseminating the Pathologies Catalogue, concsisting of a set of Pathology Reports. The Reports are grouped in terms of the constructive element in which the problem manifested itself (Figure 2).

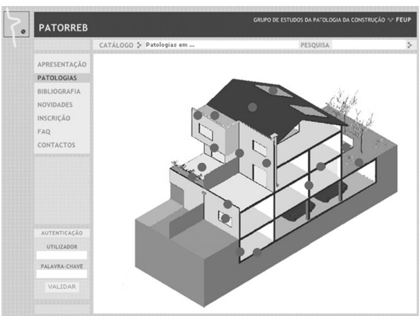

Figure 2. Organisation of the www.patorreb.com site.

4.3 Pathology Reports

The Pathology Reports correspond to a summarized description of the pathology case studies. The information is organised in five fields (Figure 3).

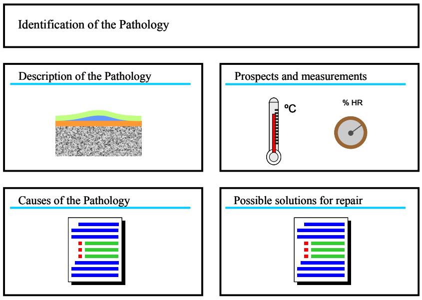

Figure 3. Standard model of the 'Pathology Reports'.

5. Conclusions

Building physics is an important design instrument, but the available knowledge which could help an analysis, is not always used. At least, the errors made in the past could be used to avoid repeating them in the future. Although Portugal has many buildings with pathologies, the information is scattered, and so its systematization is fundamental. The creation the Building Pathology Study Group and a Web site (www.patorreb.com) represents an effort to contribute to this by the publication and dissemination of pathology case studies, analysed by the various participating universities. It also serves to raise the awareness of all the actors in the construction process of the main problems, heightening the importance of diagnosis and the need to eliminate inadequate constructive solutions. The proposed dynamic model for the organisation of the information enables easy development and updating of the Pathologies Catalogue which forms the core of the site.

References

[1] Sá, Ana Vaz."Durabilidade de cimentos-cola em revestimentos cerâmicos aderentes a fachadas" (Durability of cementitious adhesives in bonding ceramic coatings to façades). Master's Disertation. FEUP, Porto. 2005

[2] Freitas, Vasco Peixoto de, Sá, Ana Vaz; "Cementitious adhesives performance during service life". 10DBMC International Conférence on Durability of Building Materials and Components, Lyon, France, 17-20 April 2005.

[3] www.patorreb.com, 2004.

[4] Sousa, Marília. "Patologia da Construção – Elaboração de um Catálogo" (Building Pathology - Preparation of a Catalogue). Master's Dissertation, FEUP, Porto, 2004

FRP straightening systems: an experimental study to evaluate their performance decay

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Starting from a complete exposition and codification of the pathologies that can affect the FRP straightening systems during their service life, the paper aims in particular to establish the protocol to conduct accelerated aging tests, using environmental cameras, in order to define the performance decay related to each defined pathology and to build the performance – time diagrams related to every component of the investigated system (or its components). The aim of the study is to define a time-decision line in order to know exactly when to start the appropriate maintenance activities in order to avoid performance deficit for FRP systems

Keywords: FRP, durability, pathologies, accelerated aging tests

1. Introduction

The topics presented in this paper is the theoretical approach to the define the protocols to conduct accelerated aging tests, using environmental cameras, in order to define the performance decay related to each defined pathology and to build the performance-time diagram related to every component of the investigated system.
This is a part of an ongoing extensive ENEA research program finalized to study the durability problem of externally bonded FRP reinforcements (FRP EBR) of masonry structures.
The starting point is the definition of the anomalies which are expression of defects and/or out of order which can affect the FRP strengthening systems during their life in order to carry out a correct diagnosis.

2. Detached anomalies

FRC support interface is the critical factor that can compromise the effectiveness of the major part of the structure strengthening applications with FRP, being this the place where the stress transfer takes place. The most typical interface anomaly is the so called peeling or better said the laminate detachment from the support at the interface; the rip-off failure which means the separation in correspondence of the terminal part of the reinforcement near to the interface but still in the support, instead, must be considered a failure dependent from the characteristics of the application surface, its preparation, and the modalities of anchoring of the reinforcement to the masonry. Beside the performance decay of the interface or the support, there can be damages at the interior of the reinforcement. Due to heterogeneity, anisotropy and the composites' elastic linear behaviour, the type of collapse it's not easily to define and can happen for one or more (in combination) of the following cases: microcracks, delamination, tearing, fibres pull-out, fibres buckling;

3. Requirements and performance specifications

The necessity of describing the "states" that the specimens have to go through during induced aging, and the codifying of those whom a certain condition of damage and, thus, of intervention have to be associated, makes the localization of the requirements of the different elements and the entire system as independent as the one for the service's specifications. The analysis can be made on the basis of the national and international laws and norms, the suggestions of the producers' manuals and of the on field experience.

4. Performance levels and state of degradations

In order to outline performance-time diagrams related to the investigated component, it is necessary to fix performance levels both intermediate and ultimate, under which the inquired component has to be considered in state of damage. In the present study, the failure is estimated in terms of performance decay of bonding capacity and strength.
In order to identify the failure due to peeling, delamination or debonding, reference will be done to the permissible threshold values (in terms of percentage of degraded surface with respect to the entire plated surface), as indicated in ACI 440 – F (2000); in order to assess tensile strength degradation, creep – rupture and fatigue performance of FRP laminates, the value of the residual strength will be compared with those calculated according to existing guidelines.
The localization of the service level is functional: on the one side it describes synthetically the life cycle of the element, on the other side it defines the kind of intervention correlated to every level.
The states of degradation are those described in the American ACI 440-F (2000) guidelines.

Such degradation states and correlated service level, encountered in the real application of FRP consolidation system, will be noticed on conditioned specimens.

5. Performance decay evaluation

Quality control of bonding of FRP on the support (masonry), can be achieved at sight (concerning coat layer), through Non-Destructive Testing (NDT) or Partially-Destructive Testing (PDT).
FIB bulletin n.14 [2] recommends the following three types of partially destructive techniques: surface adherence pull-off test (according to EN 1542), surface adherence shear test, surface adherence torque test, and four types of non destructive techniques: tapping, ultrasonic pulsed echo techniques, ultrasonic transparency techniques, thermography

6. Organization of agents causing degradation in homogenous groups

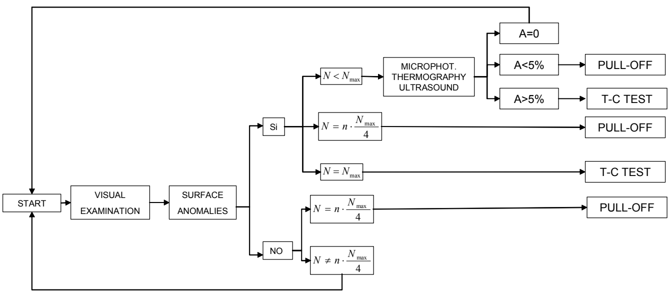
For the *mis-au-point* of the aging cycle, without being connected to the consideration of agents that can start pathologic decay phenomena, it was chosen to refer exclusively to climatic agents (excluding the ones that typically do not come up in the reference context) that can configure a physiologic aging of the reinforcement system with FRP.

7. Composition and calibrating of the testing cycles

The composition and calibrating of the testing cycles will be carried out on the references supply law, if present, and on the observation of the characteristics of the climatic context, whose effects on the chosen tests are intended to be simulated in laboratory, in connection with – in any case – the knowledge of the characteristics and the potentiality of the climatic cells of the laboratory.
With reference to the building field, there are many chambers able to reproduce the action of several external agents: humidity, temperature, temperature cycles, relative humidity, sun. With outstanding accuracy and enormous reliability, the climatic chamber is quite simply the specialist for precise, standard-compliant simulation of all climatic conditions under a constant atmosphere.

8. Planning of the execution program of the testing cycles

Once the number and typology of the to condition lab tests will be defined, the tests execution to be carried out during the conditioning will happen in regard of the flow chart represented in Fig. 2. In such a way it will be possible to set up performance-time diagrams.



N= number of cycles;
A= Area subjected to delamination, peeling or debonding;
T-C-Tests=Shear-Compression Tests;
Nmax= number of cycles after which the test is not significant;
N=nNmax/4 for n=1,2,3,4 corresponds to the number of cycles before which a pull-off was to be made in order to build a sigma-cycles number (time) diagram

Figure 2. The steps of the tests protocol

9. Conclusions

The methodology, already validated in an experimentation on the durability of continued coverings, will allow the construction performance - time diagram for the investigated technical element and for the building parts. Such diagrams will be functional to the definition of temporal threshold of intervention (to be inserted in the maintenance programs) to which interventions and/or controls will be activated on the utilized FRP consolidating systems, in the large sphere of maintenance plans of buildings.

References

[1] ACI (2000) Guide for the design and construction of externally bonded FRP systems for strengthening concrete structures, Reported by ACI Committee 440, Revised 12 July 2000
[2] Fib Bulletin No. 14 Externally bonded FRP reinforcement for RC structures, Federation International du Beton, Bruxelles, 2001
[3] ISO 15686-1 "Buildings – Service life planning – part1: general principles." International Organization for Standardization, 2000.

Sustainability criteria in building restoration: methodology for suitable choices

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Protocols and certifications for the environment and energy quality of building products and processes have been widely developed for new buildings [1]. Differently, little attention has been given to the meaning and the value of sustainability in the restoration and conservation of historical heritage. This matter is complex. Cultural and methodological issues, in fact, make unsuitable the transfer of the traditional approach to the choice of restoration solutions according to sustainability criteria. This paper proposes a specific method for assessing the sustainability for the conservation of the existing building heritage. More precisely, the method encompasses a comprehensive valuation of all aspects, as they relate to the principles of both the environmental compatibility and the historical conservation. This contribution follows a previously developed qualitative model [2] and aims at detailing and improving it, by introducing some different parameters and quantitative values.

Keywords: Building restoration, sustainability, ecolabelling, building pathology, reuse

1. Introduction

The refurbishment process of historical buildings has an important environmental value. In fact, the existing architectural heritage can be considered itself as a part of the built environment with close relationship between natural system and anthropic artefact. Furthermore, this process has cultural and economic implications, strictly linked to the basic principles of sustainability. First, it may allow the preservation of traces of historical and social development and the enhancement of local cultural identity that becomes available to global community. Then, this process may lead to recover and reintroduce a physical and economic asset into production cycle, rather than its neglect or elimination, and to manage resources more wisely as opposed to planning of new settlements.
However, some critical aspects have to be considered. First, the refurbishment process may require restoration works (static reinforcement, surface treatments and dehumidification), which employ modern products, if traditional materials and techniques are unsuitable, ineffective, expensive, dangerous or too complex to manage. These products are often manmade and artificial. They show excellent technical performances, but do not meet sustainable requirements. Then, the refurbishment process may require restoration works (functional adaptation and technological equipment), which must achieve specific performances, according to recent legislation and user needs, and, at the same time, to maintain the original features of materials and elements Nevertheless, the environmental balance is complex. In fact, the evolving demand for different levels of quality life may lead to increase energy and materials of a given system. Otherwise, the conservation need of the cultural and methodological approach may lead to limit the transformation of resources embodied in the building.

2. Methodological approach

With reference to the highlighted issues, the methodological approach to evaluate the sustainability of restoration solutions integrates two processes: the restoration practice of historical heritage and the eco-compatibility evaluation for building products. Moreover, this combination must take into account both evaluation phases and the criteria according to which the evaluation is made.
The first phase, “Conformity assessment of alternative solutions to basic requirements”, is the first control, so that any given solution does not lead the building system to an unacceptable performance level. This step is based on a set of parameters that result from restoration technical practice (‘Conservation of the historical and aesthetical value’ and ‘Compatibility with the original artefact’) and ecological assessment legislation (for instance, ‘Stability’, ‘Safety in case of fire’, ‘Fruition and Safety in use’, ‘Environmental Comfort’).
The second phase, “Characterization of products and processes for each conforming alternative solution” is a preparatory step where all the data about the properties and characteristics of the materials and the execution methods are gathered.
The third phase, “Choice of the most sustainable solution” is based upon a comparison method where a set of parameters are considered and divided into two main categories: “Sustainability of Resources” and “Sustainability of Materials”.
We have applied a multicriteria assessment, namely the *Analytic Hierarchy Process*, to define the weights for the parameters and to process the values for the

solutions. As far as weights are concerned, the method refers to an expert judgement system that is based on a pair wise comparison of the parameters resulting into a comparison matrix.
As far as values are concerned, on the basis of the energy and environment certification systems for buildings [3], the qualitative method [2] assigns a score (to each alternative and for each indicator) increasing from zero to three according to different sustainability levels. The scoring has subjective and relative nature, so that each value can be considered as a ranking more than a mark. In addition, some quantitative data, based on technical literature, are available. As a consequence, some scores have been expressed as absolute numbers. Each number corresponds to a specific interval of values that measure the relative parameter by a suitable measurement unit (for instance, Joule for "Energy consumption" or percentage of recycled material for "Recyclability").

3. Case study

The whole process has been tested and applied on Palazzo Vulpano-Sylos in Bitonto, a 15th century noble monumental building. The palace has residential use and is characterized by traditional technologies and materials. Here, some methodological remarks and final results will be outlined to highlight the main issues of the application.
Regarding the weights, we can observe that an important difference occurs between the sustainability of resources (63,1%) and that of materials (36,9%). This result shows that a solution using products with high environmental impact may be globally sustainable. Afterwards, the restoration activity is basically evaluated in terms of global environmental profit rather than in terms of balance of input and output of the single product over its life cycle. Consequently, a significant attention is given to the capability of limiting the resources for moving and laying new materials or for demolition and substitution activities. Moreover, natural materials with low energy content obviously meet the sustainable requirements, especially if they are renewable or recycled. They reduce consumption and emissions, mainly during the manufacturing process and they do not involve chemical synthesis. However, if the above stated advantages are missing, the proposed solution will still be valuable, if the production process allows the materials to improve durability, aptitude to maintenance or resistance in case of fire or leads to the conservation of the original material.

4. Conclusions

The general results of different restoration projects show that modern solutions, with innovative materials and techniques, have been generally assessed as the most sustainable ones. In fact, they perform well in terms of sustainability of resources. They reduce the need for safety measures, require low energy for execution and show high aptitude to maintenance and durability. Modern solutions also allow to maintain the original elements and a good integration with the traditional materials. On the contrary, they achieve negative results for the sustainability of materials, because of the high energy content and hazard emission during their life cycle, the chemical origin of the employed products and the weak performance in case of fire.
The method can be considered as a first step toward a practical approach to the comprehensive evaluation of sustainability in restoration practice. In addition, some important issues have to be considered. Above all, the challenge is necessary to increase the parameters that can be measured and so expressed through objective data. The general expected result concerns the assignment of a score corresponding to a range of numerical values in a quantitative performance scale. Lastly, many studies have been carried for new building materials [4], differently from restoration products and processes. Strict collaboration between research world and industry is necessary for gathering useful information (material properties, energy consumption and content and waste emission during the whole life cycle) and for arranging a data base for the sustainability evaluation.
Future research should address to the challenges of surface treatment and finishes solutions to complement the results obtained in the field of static reinforcement and dehumidification.

References

[1] CIB Report n.217, (1991) Agenda 21 for sustainable constructions.

[2] De Tommasi G., De Fino C., Fatiguso F., Napoli F., (2004) *A methodological approach for application of "sustainable" choices in building restoration,* XXXII IAHS World Congress on "Housing Sustainability of the Housing Project", September, 21-25, 2004, Trento, Italy

[3] ITACA Istituto per la trasparenza, l'aggiornamento e la certificazione degli appalti, (2003) *Protocollo Itaca per la valutazione della qualità energetica ed ambientale di un edificio*, Roma.

[4] Ianderson J., Shiers D:, Sinclair M., (2002) *The Green Guide to Specification an Environmental Profil System for Building Materials and Components*, Oxford Brookers University – BRE, Blackwell Science Publishing, London.

Running proposals to assess, manage and prevent the building decay

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In 2005 Regione Emilia-Romagna funded the LARCO research project with the main goal of improving the knowledge in the local building sector. The LEM laboratory of Ferrara, research partner, shares this common objective investigating and promoting the term of building "durability" through the development of easy protocols to manage the building decay, the risk of failures and the maintenance procedures.

Keywords: building decay, risk assessment, maintenance.

1. Introduction

The international building construction field proposes a large set of tools and surveys that promise to verify the real performances of our building heritage. But in spite of this great collection of more or less advanced systems the management of the existing designing and maintenance procedures seem to exclude their use in the working business. According to LARCO research objective of proposing a growth of the regional competitiveness in the international building market, it has been realised a framework of the existing failing features and improving strategies. The main shortcomings can be summarised as:

- a lack of information about the decay of buildings and components, in the national context.
- the International studies, tools and database have to be adapted to the local building market and to the specific Italian regulations and protocols.
- the more effective tools have been addressed to specific target groups, this needs to identify all the stakeholder of the building processes to analyse their expected requests and specific technical language.
- the use of Internet potentials doesn't increase the technical performances of the analysed tools but is definitely the most important way of spreading best practices, joining stakeholders and update the system.

Through the classification and reworking of the analysed best-practices and using the collected information about the building life cycle, the LEM [1] group wants to promote a major awareness to the building long service life, to the risk of failure and to the loss of performance inside the building process.

2. Relation between buildings and their expected decay

In the first research stage the state of the art has been investigated, overcoming the traditional concept of "expected" or average lifetime through a risk assessment approach, that is considering all building features as joint parameters with different potential influences on building decay, functional performances and risk for users.

The second phase focused some preferred relationships between the analysed features, prioritising the risk and potential effects in premature failures, to underline the importance of blending technical/functional obsolescence and building management needs. If the complexity (but also the affordability) of the expected results depends on the closeness of them to the working procedures, their effectiveness is related to the simplification of the system given by a priority scheduling method.

The main results of these technical stages include a complete analysis of selected systems and components that mainly affect the life cycle, safety and health of the existing building estate. The comparison between the performances of the most important building components as gradually assessed (in factory, as built and during maintenance or refurbishment stages) can be considered as a basic step for the proposal of a life cycle expectation really adaptable to the construction and maintenance needs. The ordinary building decay has been scheduled in working profiles (low, medium and high), along with the LC stage of each component and proposing different kind of works according to the opportunity of improving or changing the existing building performances (both technical and functional) or due to specific client requirements. This heterogeneous collection of building elements and performances underlines the will of an immediate operativeness of the proposed data, searching for the better interface between technical and functional requirements of building constructions. The International state of the art shows how the effectiveness of protocols to prevent the decay or to maintain the buildings mostly depends on the large dissemination of the technical knowledge [2]. On the other hand the usefulness of the research analysis is strictly related with a risk assessment based on "real" building life cycles [3]. Along with this feedback between research and working needs, the main result of this phase include a pragmatic scheduling of analysed information, compared and quantified, to be ready for an immediate application or to be used as part of protocols and tools arranged in the second step of this project.

3. Proposal of effective tools to manage the maintenance procedures

The proposal of effective protocols to improve the national and regional knowledge started from the collection and in-depth analysis of the international tools and methods currently applied to mitigate and control the building decay [4]. The LEM research group studied the existing public and commercial tools underlining they real application, updating and adaptability in the Italian building process. Therefore each system has been scheduled to stress:

- the main features and objectives of the tool developer (public company, insurance company, university, etc);
- the target of each specific system and the feedback protocol to suit the client expectations;
- the basic steps of the building assessment and maintenance method;
- the preferred analysis scale (material, component, etc) and the related inspection procedures;
- the tool typology (manual, website, etc), updating (short, long, etc), supports (drawings, pictures, tables, etc) and the provision of related documents (books, papers, webpages, etc);
- the required data to set up a complete analysis and any technical database linked to the system;
- the selected risk features and any other subsidiary analysis (safety, health, energy, costs, etc).

Through this report it has been possible to associate a set of preferred tools to the specific requirements of the main national target groups that could be interested in deepening their maintenance strategies (public companies, real estate agencies, building workers, designers, owners, etc). These new systems, now in the updating phase, have been distinguished into three integrated focus areas:

- analysing the building components applied to specific systems and contexts, to improve their performances and to suggest their best application and maintenance;
- assessing the building decay and the relation between potential risks, to suggest specific regulations or warranties;
- promoting the building durability, in particular for the qualification of professional workers and to inform the inhabitants.

The proper tools will be completed using the technical data collected in the first stage of this research (about the building decay and maintenance), making them suitable to the definite performance of each tool or client.

4. Current and expected results

The research expected results include: in-depth technical tables to analyse, assess and solve the major weaknesses in the building durability (components' specifications, defects, etc), priority-lists combining technical schemes and the potential sources of decay, specific guidelines and effective protocols to pilot sound decisions about building management or refurbishment. Through the feedback between all the building parties these outcomes will be strictly connected with running proposals to exploit the results (for consulting, technological transfers, etc), to share the knowledge using different kind of media (websites, publications, booklets, etc) and to continuously improve the research tools themselves.

Notes

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References

[1] LEM, *Laboratory of built Environment Maintenance and Management*, Dpt of Architecture, University of Ferrara, www.lem.unife.it.

[2] AQC (France): www.qualiteconstruction.com; BRE (UK): www.bre.co.uk; CMHC (Canada): http://cmhc-schl.gc.ca; CTBA (France): www.ctba.fr; Edilportale (Italy): www.edilportale.com; NAHB Research Center (USA): www.nahb.org.

[3] U.S. Department of Housing and Urban Development's (2000) *Residential Rehabilitation Inspection Guide*, Partnership for Advancing Technology in Housing (PATH), February.

[4] Perret Jean (1995), *Guide de la Maintenance des Bâtiments*, Moniteur Référence Technique, Le Moniteur, SNCF, Paris.

An example of large light roofing pathology: causes and possible solution

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A study has recently been concluded on the pathologies related to the roofing of a large structure designed for a flower market. The ample roofing considered, nearly square in shape (80x80 meters approximately), is "plain" as well as "light" in type. It is built of a spatial lattice structure on which metal spacers are connected to metal "IPE" beams, which in turn are joined to sandwich panels consisting of curved sheets and polyurethane foam. These panels are then covered with a mono-faced bitumen support and with an impermeable mantle in PVC joined to a spun-bonded fabric one. At the end of construction, two cases of roofing settling occurred, with the plastic deformation of the sandwich panels, the warping of the underlying carrying framework and the breaking of the impermeable mantle. The aim of the study was to identify all existing pathologies and their relative causes that also provoked static damage. Numerous complex investigations were required on the interconnected aspects: the physical-mechanical characteristics of the load bearing structure together with those of the covering in curved sheets; the compatibility of the hypothesized loads agents as a function of the free inflexion bay; the effects on the structure of the fluid-dynamics driven by the prevailing winds; the vibrations induced by them and the correct installation of the various roofing completion "sub-systems".

Keywords: Pathology, large light roofing, technology

1. Description of the roofing structure

The building consists, of a large square central hall with dimensions of about 60x60m and height of about 16m, called the "Sala delle contrattazioni".
The central hall roofing (height 21.20m) is of about 80x80m and there is no vertical connection to it the roofing having been planned and constructed as a non-load bearing cover.
This roofing was made with a "light" supporting structure. This is a spatial lattice structure (tied to the four corner blocks) on which a curved sheet has been laid, coupled to a polyurethane foam and PVC mantle as to keep out rainwater.
The roofing is raised on a substructure, bound to the spatial structure, and it consists of:

- galvanized circular steel tubes (spacers), fixed on spatial structure nodes placed on a square mesh of about 6x6m, and varying in height (from 226mm to 1207mm), depending on the required slope of the roof;
- "IPE 200" beams, 6m and 12m in length, that constitute the main frame.

2. Description of roofing pathology

A series of pathologies and remarkable degraded states were found on the roofing structure. The principal one was represented by settling of a large area of the roofing section. In reality the structure has suffered three cases of settling over its lifetime.

In all these cases, between the perimeter beam and the first parallel one, there are:

- Bending in the middle of the perimeter curved sheets;
- Torsion of the perimeter IPE 200 beam;
- Buckling of the underlying spacers;
- Folding and bearing stress of curved sheet: the first in correspondence of the internal IPE while the second of the perimeter one.

Fig. 1 Last settling of roofing

Other pathologies concern:

- Limited thickness of curved sheet, with free inflexion bay of about 6m;
- Polyurethane, deformed during heating for the laying of the upper impermeable layer;

- Total degradation of the impermeable mantle, attacked by rainwater infiltrated below the continuous mantle of PVC;
- The precarious adherence of the PVC mantle to the underlying impermeable layer.

3. Identification of causes

A hard-working and deepened study has been finished to individualize the possible causes or, better, combination of causes that have determined pathologies and degradation described above. These are causes connected to this roofing typology and that derive from the design and execution phases as well as from the management and maintenance phase.
First a high precision and punctual topographical survey was completed to verify if the four support points of the spatial structure and the same structure were horizontal. Subsequently the real inclination values of the eight pitched roof sections were measured. The first survey gave a positive result (1cm fall on 80m of distance between two support points), the second showed a limited and not uniform roofing inclination, often lower than the 2% value that is the least inclination recommended for the use of PVC mantle.

Evaluation of wind action

The wind action on the building had an important effect on the local collapse of the two zones previously specified. In case of "heavy" roofing, wind action normally has its negative effects on the surface roofing layers, also in the presence of high wind speeds, because they are not effected by the negative wind pressure
However, in the case of "light" roofing, also with no strong wind, the depression can assume values comparable to the dead load of the roofing, inducing settling for fatigue break that, as in this case, can effects the roofing support structures. A virtual aerodynamic analysis of the building was carried out using a CFD (Computational Fluid Dynamics) numerical simulations to give a quantitative and qualitative evaluation of the aerodynamic behaviour of the whole structure.
The results experimentally got show the complete overlap of the two areas of settling with those individualized by the norms.

The metal spacers

The tubular metal spacers of the roofing sub-structure are critical elements. They are notably folded up, and the weak point of the system consisting of: node - spacer - IPE 200 beam - panel - IPE 200 beam - spacer - node. This system in correspondence with the perimeter bays where the two cases of settling occurred, is characterized by a horizontal force F, acting on the summit of the panel. This force is not opposed by an analogous and contrary force. For this reason the panel, that is not able to flow in its horizontal plane, has pulled the IPE 200 beam, to which it is bound by screws, moving it from its initial vertical position and rotating it toward the building.
It is important to underline that in design phase the static verifications of the IPE 200 beams have been finished only considering vertical loads and not also an horizontal force (F), overlooking the panel deformability. According to numerical tests effected turned out that, theoretically, the panel examination involves the existence of a force F, equal to 675daN, greater than the calculated limit (equal to 560daN) with consequent spacer instability.

4. Possible solutions

The pathologies identified involve many sub-systems, the degradation of which does not guarantee their functionality or safety. For this reason the selection of possible refurbishment works on the roofing are:

- Complete removal of the horizontal roof;
- Substitution of deformed spacers and of perimeter IPE 200 beams;
- Integration of the roofing sub-structure with IPE 200 beams laid perpendicular to existing beams;
- Insertion of a rectangular section beam to reduce the inflexion bay of new panels currently available;
- Laying of curved sheet metal panels self-supporting, insulated with polyurethane and waterproofed with a synthetic mantle;
- Realization of a protected walkway on the roofing, to guarantee a pedestrian route especially necessary for maintenance;
- Dimensional, geometric and numerical redefinition of rainwater discharge system;
- Laying of a perimeter safety fence to prevent accidents that can be folded flat when not in use;
- Realization of a vertical connection to the roof, necessary for programmed maintenance.

5. Conclusions

This thorough and wide ranging study has identified different interlinked causes of the degraded state of the roof in question. Causes that find their origin both in the design phase, with reference to the insufficient inclination, to the substructure system used and to improper use of unsuitable curved sheets, as well as in the execution phase, with reference to laying the impermeable mantle. The complete lack of roofing maintenance has negatively influenced current situation, underlining once more the importance of such maintenance to the durability of systems and materials used.

The Shape-Decay Couple in the Twentieth Century Architecture

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In front of the last century decayed architectures, the responsability of what happened was ascribed to natural widely expected events, because they were results of our civilization. Therefore, the goal is to stress that it is necessary to associate with the atmospheric agents also the handwork "shape", which is strictly linked to the building technique, because both are basic causes of many decays.

Keywords: pathologies, decay, design, carrying-out

1. Introduction

Various decades have already passed since the first steps were taken in the field of pathologies and building decays both in the professional sector and at university, where the teaching of the building recovery was not envisaged. Since then an increasing attention to the problem has been paid, which gave rise not only to many contributions in the debate regarding the building and environmental recovery but also produced a wide sectoral literature.
Because very numerous decays are spoiling the ancient and as well as the so-called modern buildings of our towns.
The causes are many and broadly documented and

- they derive both from the dreadful environmental conditions (smog, acid rains, pollution and so on),
- the little knowledge of the chemical-physical characteristics of materials utilized by planners,
- and the handiwork plan which is often wrong and/or not properly carried out.

Besides these motives in accordance with the rules of the modern architecture, the designer proposes pure line manufactured articles made with new materials, acclaimed by producers but which, once got down to work, deteriorate in a short time.
In short, only a good knowledge of the materials used, a correct design and execution of the architectural handiwork can limit the many types of decay.
In the architecture of the past, builders constructed handiworks in stone which had to last indefinitely if they utilized high quality materials and carried out them properly.
These concepts, already stated by Vitruvio Pollione (1), are concurred by other distinguished architects in their writings in the following centuries.
In the twentieth century, the best-known exponents of the modern movement made the pillar and the beam system become of common use employing the reinforced concrete already experienced in the second half of the nineteenth century together with the section irons and put an end to the heavy system and to the disappearance of both the traditional building techniques and of stone masters, holders of a trade which was handed on from father to son.
This artificial stone, being able to assume the carpentry shape and having a very good resistance both to the compression and traction, has made possible daring shape handiworks. It has deceived designers and not qualified building contractors without any suitable professionalism, that the reinforced concrete might work "wonders".
The duration of handmade articles, built in the second half of last century, has decreased considerably because of pathologies and deteriorations, which had begun since their finishing (2).

2.1 Linearity of shapes

The impulse to take away every decorative unit entailed the exclusion of those architectural parts, which had, instead, a definite function chiefly towards atmospheric agents and which were not simple decorative components.
It was an usual procedure that roofs jutted out broadly from faces to safeguard façades from the rainwater.
The fashion of not using the crowning cornice lead planners to think up innovative steps from an aesthetic standpoint, but that the time will demonstrate their ideas are entirely wrong because they facilitate blooms, stains on faces.

2.2 Crowning cornice design

A curved surface, free from an apt drip, does not take away the water from the face, but spreads it towards the front along with structural damages to the cornice aided by the dangerous carbonization process.

3.1 Overhanging structures

A rational analysis of plan errors cannot dwell upon an overhanging structure common to many buildings that is to balconies.
They, often become typical elements of modern architecture façades, are the most exposed to air pollution and hence subject to a higher decay.
Moreover, it is well-known that, from the statistical point of view, the balcony recovery ranks often first in the items of architectural handiwork renovation.

3.2 Static structural failures

Architects and engineers know well the strains to which a bracket is subject and they also know that balconies must bear tensile compressive stresses. But, perhaps in pursuit of cutting down expenses or decreasing weights, most times brick-cemented balconies are built and are still being built, consequently they become very fragile.
The brick stands to compressive stresses well, but in balconies, perforated bricks break because they do not stand the compression.
Also reinforced concrete balconies are not free from problems. In effect they deteriorate early, if they are not constructed according to teachings of good erecting.
The reinforcing rods are very often laid directly on the mould; this method of operating does not enable the concrete to absorb the rods altogether. Therefore, it oxidizes because it is not protected from atmospheric corrosion.
Owing to the oxidation the rod volume increases, which breaks the mix fostering the growth of cracks.

3.3 Aesthetics and technology

In addition to static-structural problems, the attention is paid on the balcony shape, both as design and as study of materials to be utilized and technological-building decisions to take.
The above is a thing of a paramount importance because the project designer devises shapes aesthetically substantial but wrong from the building viewpoint.
Planners, in order to obtain an increasingly original shape, are also inclined to build reinforced concrete parapets, forgetting to respect the real features of the material.
You can very often see so thin parapets that the iron cannot be protected in a suitable way. Therefore the quarry face concrete moulders early bringing about considerable shortcomings and a large amount of money of renovation.
Moreover, the balconies with full parapets have the big trouble of the raining away of water, because often small-sized gargoyles do not make the water flow quickly. It turns out that the stagnation makes easier the going back up the parapets, which getting wet, gives rise to blooms.

4. Conclusions

Due to a number of pathologies in addition to the natural decay, the modern architecture, or "architecture of decays"(2), is compelled to pay a very high price.
It is hard to identify the best way to solve this problem within the building field, where the common say "A stitch in time saves nine" does not really apply.
Bearing in mind that pollution is a element difficult to neutralise in the short term, we are able to identify other causes that have crucial impact on both the aesthetic and economic level, which remarkably reduce the lastingness of our building, as follows:

- Planning errors together with inexperienced and careless direction of works
- Wrong building techniques, absence of planned/progressive maintenance, as most commonly adopted the breakdown maintenance approach
- Poor knowledge of how to employ building materials i.e. cls of c.a.

All these elements combined with external environmental factors such as acid rain, if taken into account and prevented, could reduce the risk of the decay, characterizing the modern building industry and avoiding unnecessary and expensive recovery operations.

References

[1] Vitruvio Pollione M., *De Architectura*, a cura di Franca Bossalino, Kappa Ed., Roma, 2002.

[2] Brancato F. S., *La prevenzione del degrado*, ILA PALMA Ed., Palermo, 1991.

Eleven steps to high building performance and to building sustainability

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The indoor environment reflects our standard of living, influences our productivity, and affects our health. This indoor environment comes at a cost to the outdoor environment. This cost is particularly great when building performance is poor and inefficient. This paper presents nine steps to achieving maximum building performance and reducing the negative impact of buildings on the planet.

Keywords: Building engineering, building performance, energy use, sustainability, building envelope.

In the last century with the advent of the elevator and air conditioning, buildings have become more and more technologically complex. We have come to expect indoor artificial environments that are healthy and which provide us with comfort, safety, and all sorts of amenities for our living styles, work, and play. This artificial indoor environment comes at a great cost to the outdoor environment.

Building construction accounts for 40% of raw stone, gravel, and sand used, 25% of virgin wood, 40% of energy, and 16% of water used annually worldwide [1]. The bulk of our energy supply comes from oil and coal. The byproducts of this energy consumption cause global warming, pollution, and ozone depletion. For example, if the current trend of energy consumption continues, it is estimated that the global annual average temperature could rise by as much as 5^0C. by 2100 [2]. In fact, global energy is expected to increase. In North America we are now the largest consumers of energy compared to other regions of the world. However, we know that there are other parts of the world with rising economies that are bound to move the trend of energy consumption upward. The buildings that we build today will be contributing to this consumption increase and global warming throughout this century.

This vast problem can be reduced significantly by recognizing and pursuing the following 11 steps in the production and operation of buildings:

(1) Reduce rate of current building failures through better awareness and implementation of available knowledge, products, and techniques. For example, current buildings produce indoor environments that are usually expensive to operate and often harmful to our health. We have often heard complaints about sick buildings, poor ventilation, rain penetration, and air infiltration. Ventilation plenums and ducts accumulate dust which can breed mold and other microorganisms that contribute to the pollution of the indoor environment. Similarly, water accumulation in humidification systems can breed microorganisms that will migrate through the ventilation system and become associated with air quality problems. Water runoff over the façade of the building envelope leads inevitably to water penetration, deterioration of the structure, and loss of thermal resistance of the envelope.

(2) Create the awareness that it pays to improve building performance and the indoor environment. We must remember that the total life cycle cost of the building can be as little as 5 to 10% of salaries paid to occupants over the life span of the building. It is important, therefore, to design and operate buildings to provide the most productive environment for people using it.

(3) Improve building performance by accelerating the pace of implementation of new technologies and better design. For example, create local environments to reduce requirements for the overall indoor environment, make better use of solar energy by using spectrally-selective glazing, switchable glazing, and improved curtain walls with higher thermal resistance. Design ducts for easy access and cleaning. Avoid sound insulation in ventilation plenums as its fibers can be released to the interior environment. Use mufflers instead.

(4) New technologies need to be integrated in a holistic approach in the design of the building. Structures, envelope, services, and mechanical systems are often implemented as independent components, yet they must work together. Some of these disciplines are more advanced than others and performance will be determined by the lowest performer. For example, the envelope, like structures, accounts for 20% of the building cost, but accounts for 50% of the failures, because it does not receive as much R&D attention as some of the other sub-disciplines.

(5) Improve the building process to reduce cost and resources. High-performance buildings will return large savings in the long run. Higher front-end investments and incentives are required to support the implementation of these technologies, the R&D to ensure performance of new technologies, and provisions to reduce the time lag for implementation of new products and techniques.

Savings become obvious when we consider the costs associated with the life cycle of the building. The life cycle of a building can be divided into three phases: design, construction, and use. While the design stage is the shortest of the three, it has the greatest influence on the expenditures of the subsequent phases of the building.

Cost deviations at the construction stage vary according to the quality of design. The less defined the design, the greater the variations in construction cost due to change orders, and modifications on site.

Similarly, the lower the consideration given to features related to the maintenance and operation of the building, the greater the variation in operating efficiency and therefore costs in the maintenance and operation of the building.

(6) Building performance must be an ongoing concern. Buildings begin to deteriorate soon after they are completed. Hence, maintenance must begin at the time the building is completed. Extending the life and effective operation of existing buildings relieves the demand on world resources for new buildings.

(7) Professionals must be trained to bring to bear state of the art knowledge on the building process. High building performance can be achieved only if the professionals involved with the building process are well equipped with the latest knowledge in the relevant technical areas such as: building science, the building envelope, energy use, indoor environment, and construction management. Educational programs supported by strong R&D activities and advanced facilities need to be reinforced where they exist and new ones need to be established.

Since the early 1970s we began to establish programs in Building Engineering at Concordia University that featured all the areas related to the building process. This year (2006-07), we have approximately 209 undergraduates and 192 graduates, including 46 PhDs, enrolled in the program.

(8) An adequate knowledge base must exist at the design stage and it must be well coordinated. This knowledge can be provided by well-coordinated teams of professionals since it is difficult to find all the expertise required in one individual. The owner needs to be better informed to be an effective decision maker. The responsibility given to a professional must be matched with the knowledge and deliverables of that individual. Deliverables must be measurable in terms of performance both short term and long term.

(9) Increase the demand for education in Building Engineering by hiring building engineers. Often other engineering disciplines are advertised for building engineering work, because Building Engineering is not yet well known.

(10) Increase R&D by establishing university research chairs in building research and involving graduate students to help resolve problems encountered in industry.

(11) Buildings provide for our well-being and represent common resources of society. They also represent our culture, values, institutions, and traditions. We all have a professional, social, economical, and moral obligation to see that buildings are well designed, well operated, and well maintained.
Since buildings shape our lives, let's make sure that we shape our buildings to function well.

References

[1] D.M. Roodman and N. Lenssen, (1995) *A Building Revolution: How Ecology and Health Concerns are Transforming Construction,* Worldwatch Paper 124, Worldwatch Institute, Washington, DC, March

[2] Time Magazine, Canadian Edition, August 26, 2002

INA-Casa quarters in Genoa: construction culture, pathologies, preservation

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The paper concerns a recent research focused on the analysis of INA-CASA Quarters in Genoa (1949-1963). Main objective of the research is the acquisition of knowledge on technical and constructive features of the buildings, on their actual obsolescence and on the possible causes of building pathologies, in order to prepare guidelines for their preservation and refurbishment. Specific objective of the research is the recognition of pathologies, defects embedded in the buildings, mistakes eventually made during the planning, design and building processes (pathologies and failures)..

Keywords: building pathology, defects, technology, refurbishment, social housing.

1. The INA-Casa in Genoa: construction culture

The construction of INA-CASA quarters all around Italy after the second world war has been an extraordinary experience of the recent history of architecture, for social, urban, typological, architectural and technological reasons [1].
The main criterion followed by the INA-Casa management was to avoid any repetition of standard building types, committing the architectural design to outsider professionals. The new buildings, that had to be "healthy and modern" became an occasion for Italian famous architects to enrich social housing quality, closer to the international models. In order to achieve an unit design, the INA-Casa agency publishes four handbooks regarding Guidelines, Technical codes, Schemes and Contract terms.
These guidelines go with the whole building process, from the beginning to the final test, aiming to train technicians involved in the re-construction after the war and to coordinate them with the specific and peculiar local situations.
In 1949 INA-Casa Agency grant to the Municipality of Genoa economic fund for the realisation of 35 buildings (after 14 years there have been built 112 buildings). The Municipality contributes with the donation of the lands and providing for the architectural projects, the contracts and the technical direction; only few cases are committed to outsider professionals. For this reason the architectural features of the quarters in Genoa appear in contrast: from one side the ordinary elements, as suggested in the four handbooks, on the other side some building blocks (made by L.C. Daneri, R. Morozzo della Rocca, Gruppo Ginatta) characterised by technical, architectural and constructive experiments, totally different from the prescriptions.
Above all the works by Daneri claim their loyalty to the rationalist research, showing the prefab in reinforced concrete, the "pilotis" system that move the block away from the sole, the typological and technological standardisation [2] [3] [4].

2. Pathologies, failures and defects: a compared analysis

Specific objective of the research is the recognition of pathologies, defects embedded in the buildings, mistakes eventually made during the planning, design and building processes (pathologies and failures). The research assumes as “pathology” the discipline that studies mechanisms and factors that lead to a premature obsolescence, when, for example, physical alterations or performance defects, or in other cases, failures become earlier than expected [5] [6] [7].
The fundamental hypothesis is that the actual obsolescence of the buildings is due to different aspects:

1) building technologies, linked to the specific post war technical culture;
2) technical codes of “INA-CASA Management” (concerning general planning, building typologies, building technologies);
3) untypical architectural and technical solutions assumed by local designers (compared with INA-CASA codes);
4) effective technical ability of building companies to interpret the proposed solutions.

The experimental method of the research consists in the recognition of the signs of obsolescence comparing the technical prescriptions and codes of INA-CASA with the real cases and their written history (technical drawings and documents), to identify direct causes and aggravating situations and, secondary, any differences between national and local context.

The first interesting result of the compared analysis is that only in few cases the actual problems are caused by mistakes inside the INA-Casa technical codes and regulations. Another important fact is that INA-Casa, during the second seven years, concentrates its activity in a general revision of technical principles assumed, towards a normalisation of the design and constructive process. During this period, in fact, the Agency revises the first and the second handbooks, outline the positive aspects and indicates the technical solutions to be followed (third and fourth handbooks).
Looking deeper at the Genoese cases, it is possible to distinguish between the general problems linked to the contemporaneous constructive culture and the peculiarity (both in positive and in negative way) generated by the presence of skilled architects. It is a fact that most of the quarters are located in areas exposed to the action of dominant winds or in a very humid context (small valleys closed by vegetation and buildings): this condition had surely a bad influence on the general "behaviour" and life span of the buildings.
General and common problems, depending on the general constructive culture of the period, are located in the reinforced concrete structure not protected by a layer of plaster, especially in contact with the ground floor, or in the window frames where were used simple iron not protected by the corrosion. The pavement of the ground floor and of the porticos, without sufficient slope neither expansion joints encourage the infiltration of rainwater. Again, the assumption of the plan roof together with the architectural shape of the windows, lacking of elements of protection, causes almost everywhere the same kind of defects (infiltration, solar exposition, break of small pieces…). The asphalt material used at that time for the waterproof protection of plan surfaces (especially in the roof) appears weak under the effect of solar radiation, as well as a wrong execution of the joint between the waterproof protection and the vertical wall, or the lack of covers or the use of very thin metal sheet causes infiltration from the top.
Nevertheless, in some cases the technical skinless of the architect overcame INA-Casa prescriptions. L.C. Daneri, who was very careful in the design of details, together with R. Morozzo della Rocca, R. and G. Ginatta choose, for the external balconies, a rectangular section characterised by a plane surface on the lower side instead of the slope one. This solution avoid the infiltration of rainwater, that consequently causes the chemical decay of the concrete and the corrosion of iron and steel. Again Daneri correctly studies and verifies, during the execution of its works, the detail of the covering, the junction between elements, the protection from infiltration, choosing a pavement system for its plan roof that could protect the asphalt from deterioration.
Weather INA-Casa prescriptions preview the simple insert of the metal railing inside the concrete slab of the balcony, Daneri and Morozzo design the connection between the two elements with the insertion of a lead element. In the meantime, the skinless of the authors lead them sometimes to path new ways in open contradiction with the prescription of the Agency. The will to experiment architectural innovation (especially in the complex of via Tofane and Forte Quezzi) force the project to open loggias on the north façade, later closed by the inhabitants form climatic reasons. This successive modification generated a strong debate on the opportunity to preserve them or to come back to the original aspect.

3. Results

INA-Casa quarters represent autonomous and recognisable urban episodes that are characterised by an original architectural language. Although their state of decay, due also to the lack of maintenance, they still maintain a precise identity. The preservation, refurbishment and recognisability of these quarters have to be kept as main purposes of any intervention. The analysis of the current state of the buildings, of their constructive history and of the recent maintenance (sometimes correct, sometimes wrong) should be the basis to program and to operate on them correct interventions. Further result of the research is, in fact, the evaluation of the negative impact of maintenance and refurbishment on the original image of the quarters.

References

[1] AA.VV. (2002) *L'INA casa: il cantiere e la costruzione*, Gangemi, Roma.

[2] Braccialini M. (1949) La nuova edilizia popolare, *Genova*.

[3] Bracciali M. (1953) Edilizia Popolare, *Genova*.

[4] Christen A. (1950) Case del Piano Fanfani a Genova, *Urbanistica*, 3.

[5] AA.VV.(1981) *Patologie in edilizia*, Be-Ma, Milano.

[6] Croce S., Costantini M.(1982) *Patologia edilizia*, Be-Ma, Milano.

[7] Croce S. (1995) Patologia edilizia: prevenzione e recupero, in AA.VV. *Manuale di progettazione edilizia. Progetto tecnico e qualità*, Vol. 3, Hoepli, Milano.

Investigating and remediating leaks in below-grade structures and under plazas

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The protocol for investigating leaks in below-grade habitable spaces consists of obtaining background data, performing a leak survey and observing conditions above and below grade. This paper discusses these procedures and reviews causes of water leaks in basemenst. It provides recommendations for alleviating water pressure by altering above grade components and topography, installing drains, re-waterproofing and stopping water infiltration by application of cementitious materials, injection of grouts and chemicals in and behind foundations and slabs.

Key Words: Leaks, Investigation, Remediation Injection

1. Introduction

This paper discusses methodology for investigating the cause of leaks in below-grade habitable spaces. It provides recommendations for alleviating water pressure by altering above grade components, draining and pumping and stopping water infiltration by injection of chemicals in the surrounding soil, in cracks and joints in and behind foundations and slabs.

2. Investigation methodology

When roofs leak, the leak sources can often be quickly identified and repaired. Most roof membranes are usually accessible. Conversely, when water infiltrates a basement, either through the foundation or the slab on grade, the conditions are much more serious because leakage can make an underground space uninhabitable. Ascertaining the cause and instituting appropriate corrective measures can be difficult and costly. Usually the foundations and slabs on grade and surrounding soil cannot be easily removed for inspection. Furthermore the process can be disruptive to the building occupants, damaging to the waterproofing itself, difficult to achieve and not always productive or cost effective.
But remediation can be accomplished by a number of methods most of which are familiar to building pathologists and which are discussed in this paper.

2.1 Accumulate historical and other pertinent data

Obtain and review original construction drawings; research records of unusual climatic events; check for recent seismic events; research nearby construction activity. Acquire the geotechnical report, construction documents, a record of any previous repairs or of recent structural alterations and interview building personnel.

2.2 Perform a leak survey and record observations

Prepare a drawing of the premises and chart all active leak sites and passive leaks sites that have been repaired.

3. Cause determination

Leaking through concrete foundation walls and slabs on ground usually exhibits itself at cracks, cold joints, expansion joints and penetrations. It is generally caused by either a failure of a structural element or components of the waterproofing system coupled with an unanticipated increase in hydrostatic pressure.
Structural failure may exhibit itself as cracks or opening of construction joints occurring from overloading, settlement, vibration, seismic events, creep, shrinkage, vehicular surcharges or adjacent construction activities.
Leaking in below grade walls and slabs is often caused by an unanticipated increase in hydrostatic pressure. It can be due to an intermittent rise in the water table or from a surcharge of water in the soil surrounding the foundation.
The source of an increase in hydrostatic pressure can often be identified by observing the color or odor of the infiltrating water or by chemical tests.

4. Remediation materials

Crystalline, hydraulic and oxidized metallic cements and other cementitious materials penetrate concrete pores and react with water to expand and seal active leaks.
Sodium and calcium bentonite, clay based grout expands upon contact with water form a curtain between the concrete and soil.
Epoxies are the preferred material for repairing structural damage. They can also be used to stop leaks, but are not as effective as the chemical gels. They adhere well, but are relatively inflexible and do not tolerate movement.

Chemical gels, such as urethanes, acrylate polymers and similar hydrophilic chemicals injected into cracks and joints, expand on exposure to water to stop leaks.
Chemical urethane and acrylate polymer foams and similar hydrophobic chemicals also expand in contact with water. When injected behind foundations and under slabs they form water impenetrable curtains.

5. Remediation methods

The location and severity of the leaks will generally determine the most appropriate method of remediation. Often more than one method is required. Critical factors for selection are access to the foundation and slab from the interior or exterior, the degree of disruption to the occupants and budget constraints. As a rule, it is best to begin with the simplest and least expensive method and graduate to more complicated and costly remedies.
Based on results of the leak investigation the building pathologist should select one or more of the following methods:

- Reduce hydrostatic pressure by altering above grade building components and topographical features.
  - Install roof gutters where they are absent.
  - Add or install downspouts or increase their size.
  - Connect downspouts to a storm water sewer or extend to daylight away from the building.
  - Ensure positive drainage away from the building.
  - Divert water by swales or curbs.
- Drain water by: installing drains and pumps within basements.
- Repair or replace positive side waterproofing.
- Apply crystalline, hydraulic or cementitious/metallic coatings to interior surfaces or grouts in joints, cracks and holes.
- Inject sodium bentonite clay in the soil from grade around the foundations.
- Inject epoxies in cracks and joints.
- Inject sodium bentonite under slabs.
- Inject urethanes and acrylate polymer grouts into joints, cracks and holes.
- Inject urethanes and acrylate polymer foams behind foundations and under slabs.

6. Conclusion

Basements leak because of failure or absence of a positive side waterproofing system, movements that open cracks and joints and unanticipated hydrostatic pressure. The protocol for remediating these leaks involves investigating their history and phenomena that may have changed the environment; the source of water that caused the pressure increase and selection of the most appropriate methods for remediation.
These include controlling water flowing from roof drainage systems, modifications to site topography, re-waterproofing, installing interior perimeter drains, injecting bentonite clay into the soil surrounding the foundation, injecting chemical gels in cracks and joints and injecting chemical foams behind walls and under slabs.
The building pathologist must ensure that the structural components will be capable of withstanding the pressure of the clay and chemical injections and the ensuing hydrostatic pressure.

Recurrent pathologies in recently built schools in Palermo

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This topic concerns the most significant pathologies noticed in the facilities being used as schools, which were built in Palermo in the last three decades. Many among these facilities already have undergone major restoration works, while the others are in poor conditions, which remarkably compromise the quality of their utilization. Sober elegance and safety are particularly important whenever a facility is to function as a school, especially if we consider the type of users and the ways of utilization. In order to achieve such goal, it is fundamental to analyse the most frequent pathologies, relating them to their causes, so as to have the tools for correcting previous errors and prevent any future mistake. The results showed that some particular elements of the facilities presented the most severe pathologies, which in most cases could have been avoided if projects had been more attentive to the durability of the technical solutions.

Keywords: Pathology; reliability; maintenance; building failure cases; schooling premises.

1. General aims of the study

Whatever the various forms that the deterioration in the quality of a building may assume, the pathology is characterised by the unexpectedness of its timing. Although it may be intensified by natural agents, the pathology derives, above all, from human factors. It is for this reason, as regards the inevitability of decay (a phenomenon of physiological ageing), that the pathology may be considered avoidable. Generally speaking, the main aim of the study of this construction pathology is to succeed in forestalling and containing this phenomenon. Apart from a few general methodological principles, the studies of construction pathologies arouse interest above all when dealing with specific cases. In fact, beginning with its actual identification, the pathological phenomenon is clearly characterised by reference to the specific materials and solutions adopted. For this reason it has been decided to analyse the pathologies recurring frequently in buildings that are homogenous with regard to origin, type, condition of use and management.

2. The case-study under examination

The research described here was prompted by a study that is still going on, with regard to building structures to be used as school premises (state property in the district of the City of Palermo). At present a *house-keeping* model is being used as a management system, based solely on the utilisation of internal resources. The *Maintenance Sector* of *Ufficio Autonomo Edilizia Scolastica* is responsible for a group of 190 fairly heterogeneous buildings. The school–buildings constructed following the Falcucci decree are a clearly-defined sample of significant dimensions and, above all, homogenous in quality: there were in all 38 buildings, corresponding to 20% of the total number of structures, united above all by an urgent need for operational processes: the planning for these buildings was severely conditioned by the limit on costs; the operational phase was also particularly long and tiring, in certain cases only concluded after decades of interruptions.

3. Recurrent pathologies

Although they had been built quite recently, there were rather obvious phenomena of pathologies and decay in the cases being examined. The examination carried out on building pathology stems from an overall pre-diagnosis of the structures, aiming to discover their construction efficiency, via an analysis of technological features and a process of analytic and critical de-construction. The framework of pathologies proved to be complex and in certain instances astounding. This paper has described only the most common and significant examples from the buildings under examination.

The main pathologies noted develop on the surfaces, where plaster facing is an element used in all the cases under examination. The most commonly recurring pathology is the surface layer's lack of adherence to the underlying support; this initially reveals itself in the form of bubbles of various sizes, and subsequently in the breaking up of the surface and the complete detachment of the facing. This pathology is quite widespread, but crops up mainly in those areas that are subject to the action of water. This pathology stems, above all, from the nature of the material employed, plastic plaster, which is notoriously nontranspiring, and is associated with a notable quantity of water in the construction elements. Another determining factor is the absence of planning precautions, which accelerate the weathering mechanisms and the consequent deterioration of performance. In the case of wall-ground junctures, the water is absorbed in capillary fashion from the ground and conveyed to materials with a porous structure, such as calcarenite ashlars and lateritious bricks. The phenomenon is also emphasised by defects such as the absence of waterproofing, loose stone foundations and interspaces, and precautions for draining off rain-water. Another area where this pathology is to be found is in attic walls; in this case the source of the agent is the rain-water that has fallen and collected, and the inadequacy of the drip. More generally, the lack of precautions for the run-off of rain-water, with the glaring omission of spouts and suitable connections between the parapets and the slabs, has created favourable conditions for the development of this pathology.

Another element that plays an important role in the quality of construction covering is roofing, that in the cases analysed is flat and continuous, mostly covered with a waterproof membrane. In this part of the building the most common pathologies are principally failures resulting from the discontinuity of the waterproof layer and the presence of cracks where the roofing joins the attic walls. The agents responsible for these pathologies in wall-facing emanate from a situation where, because of direct exposure to the atmosphere, the walls are subjected to continual expansion and contraction due to swings in temperature. Furthermore, the permanent presence of water, emphasised by the erroneous execution of the gradients, the inadequacy of the rainwater pipes, the absence of grills to prevent leaves entering, and by a neglect of cleaning operations, brings about infiltrations inside the building, to which there are corresponding stains, efflorescence and haloing. Collected rain-water on the roof-covering causes trickling along the horizontal cracks, which are level with the juncture of the attic walls. As regards the decline in performance of the waterproof membrane, the origins can be attributed to the planning phase, where materials may have been utilised with restricted coefficients of thermal expansion, as well as the absence of protective elements. Another very serious shortcoming in planning is the absence of an expansion joint between the roofing and the attic wall.

The buildings examined were made entirely of reinforced concrete and displayed the typical pathological framework, characterised by large areas of detached cover and iron oxide stains, which were present above all in critical areas. It is widely known that there are numerous causes for this pathology and they crop up mainly during the phase of execution. Some of the buildings examined have the steel structures of external fire escapes; both the trimmings and the supporting elements commonly display signs of oxidisation. At the root of this pathology there lies the absolute indifference, during the planning phase, to the need for durability; structures are often designed as if they were to be located indoors.

4. Conclusions

The homogeneity of type and construction that characterises buildings under examination is reflected in the recurrence of specific pathologies, which appear regularly in certain components of construction systems. The structured analysis of significant pathologies provides an instrument for a more efficient management of these buildings. In fact, via the individuation of their origins, it provides the opportunity to understand pathological manifestations and to predict their subsequent evolution. This contributes considerably towards defining the most appropriate strategies, starting with a choice of the most suitable category of intervention for resolving the pathology in question. Determining the intervention required to resolve the pathological phenomenon is the first step in the planning and management of building operations, which, in the case of school premises, are of extreme social, as well as economic, importance; security, in all forms, and propriety are particularly sensitive objectives in school buildings, if we consider who is going to use the building and in what way. In the paper being presented, the analysis of building pathologies serves to help understand the errors that have been made, so as to curb damage and forestall further future damage; the present generation has a duty to bear in mind past experiences (including those from the recent past), and pursue the values of sustainability both in construction and human activity in general.

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A methodological approach for the durability of recovery interventions

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The research intends to make a study of the interventions of restoration realized in Basilicata, (both of traditional or innovative techniques and of natural and synthetic materials), aimed at predicting the durability of useful life and of the acceptable state of the parts and the buildings in conventional normal conditions. The aim is to establish an operative methodology for the durability of the interventions based on a quality approach of the various phases of the process of building restoration, and also to carry out an interdisciplinary project defined between tradition and innovation defined by the quality classes of the building organism.

Keywords: durability, recovery interventions, compatibility, rehabilitation, programmed design

1. Planning Methodology for conservation and recovery

If retrieval is meant as an attitude towards the wish for giving more "value" to objects, restoring means first of all that the object is very important, even though it is strongly damaged. The conflict of values would seem to be unsolvable, giving importance from time to time to the most appropriate value for a work or a ruin. This will be true, if some "contradictions" are widely known between value of antiquity – made up of defects and lack of unity – and historical value, assuming that the monument is preserved complete and intact, in order to keep the authenticity and historical reading data the most. It will be also true, if both value of antiquity and historical value are inversely proportional and if colour and shape perfection (however utopian) and "youth better than old age" are a value for Riegl.

2. Methodological approach

The above mentioned considerations point out the complexity of the issue in question and the necessity to face the retrieval problems following a rigorous approaching procedure, based on the following operating stages:

a) historical-archival research;
b) the scientific survey and the state of conservation;
c) through the above mentioned survey of technological networks;
d) defining a visiting and fruition system, paying particular attention to safety;
e) defining existing static, preventive and material problems.

3. Time evolution of the damage in ancient building structures

In retrieval and conservation field it has been found the necessity of making use of specific techniques to test the structure real conditions of damage, before arranging any intervention. The purpose of this research is applying the same intervention methodology to the sample area, the 'Sassi' of Matera, re-examining what has already been established in a previous study led by a research group from the Polytechnic of Milan.[1] An experimentation campaign and a theoretical modelling will be carried out, holding the features of the material making up the building structures in Matera. The work can be summarized as follows:

a) Mechanical characterization of the material;
b) Carrying out a theoretical model;
c) Applying the model to the simulation of experimental tests;
d) Defining the time evolution of the damage;
e) Drawing up the guidelines.

4. Taking and identifying the samples

The campaign of taking material has been studied and considered because of the wide size of the sample area and also because of the difference being in the area itself, inside a single site, building or masonry itself. The 'Sassi' own nature, their building features, the material used to make buildings, the thickness of the calcarenite outcrops and the structure of the town itself cause the above differences. The material has been taken from different and various areas of the town and in very different conditions.

5. Buckling tests

The compression force is the mechanical feature through which a material is marked. This value of force is achieved subjecting cubical test pieces of agreed size to simple compression tests. Processing buckling test data concerning the single test pieces, the same number of step-force (s, F) and deformation-tension (ε, σ) graphs have been drawn, getting the ultimate tensile stress of the single cubes. Tension values σ (Mpa) fluctuating from a 0,222 MPa minimum to a 3,958 Mpa maximum have been achieved. These differences in results are due to:

a) heterogeneity of the material coming from quarries and different sites;
b) local defects;
c) geometric and contact defects.

6. Creep tests

Creep test tries to check deformation progress in time under constant load. In fact, by means of this test, it is possible to check the material tendency to fracture, if it is subjected to a constant load lower than monotonic ultimate tensile stress, but given for a longer time. Under those circumstances, on test pieces taken from the area in question - knowing the single test pieces hypothetical ultimate tensile stress, drawn from buckling tests carried out on samples having the same size, taken from the same site and with similar features – a creep test has been carried out using consecutive increases in simple load, in order to reach the ultimate tensile stress after about twenty increases carried out every thirty minutes. Examining these charts it can be observed that:

a) It is quite difficult to distinguish the three Creep phases definitely;
b) The third creep is almost non-existent, because the test piece fractures as soon as this phase starts;
c) The test piece fractures instantaneously after some increases in load;
d) The type of material's fracture can be classified as fragile;
e) The fracture of the material takes place because of very variable loads and increases in load as in the case of buckling tests.

7. Application of theoretical calculation model to experimental tests

The adopted model main feature is indeed its simplicity and the possibility to draw a theoretical curve from Kelvin (E^K and τ^K) and Maxwell (E^M and τ^M) variables. This theoretical curve represents time evolution of deformations disregarding possible changes in deformations due to the damage which actually starts at a certain point and at a definite σ value. This model has been applied to the real MT-C-20 test piece of the creep test, that is to the charts drawing from the calcarenite test piece, coming from Matera's quarry. The same increases in load used for laboratory experimentation have also been adopted for numerical simulation. In order to simulate the real behaviour with the theoretical model, it should be necessary to consider the material's damage, suitably rising the deformation to the i generic.

$$\Delta\varepsilon_i = \Delta\varepsilon_{i\ \mathrm{model}} + \Delta\varepsilon_{i\ \mathrm{damage}}$$

It can be observed how the progress of the two curves – the one drawn from the experimental test and the one drawn from the theoretical model, adding the damage is very similar. The first immediate results coming from the numerical treatment can be listed as follows:

a) The first damage of the material subjected to a constant in time load – related to the fracturing tension of the material, which is drawn from a buckling test – is about 40 %.

b) The damage can be correlated to the tension state through a (Δε damage, σ) linear law, ie. (Y = 0.0391X). For this reason, knowing the tension value which a structure is subjected to, the damage value can be drawn;

c) The achieved results could be applied to tufa plates on site.

8. Conclusions Creep tests

The pieces of information drawn from the theoretical model can be used in order to restore the efficiency of a masonry subjected to constant and durable loads and therefore an element being easily usable in the sample area, where buildings are made up of calcarenite masonry, but being also extended to other contexts (other historical centres or masonry structures). The results – which have been drawn from this experimentation - can be used in order to define pretensioning to apply to reinforcement scantling devices. For example, in case of building structure showing yielding because of lasting and strong stresses due to the viscous damage, if there are masonry pillars and columns.

References

[1] Il progetto di conservazione: linee metodologiche per le analisi preliminari, l'intervento, il controllo di efficacia by Pesanti S. (2001), Alinea Editrice.

Analysis of a Building Collapse: an examination of investigation methodology

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Whilst much has been written about the diagnosis of defects in buildings, little has been written about the methodology of the examination of a collapsed building. This paper looks at the methods used to determine the cause of the collapse of a building and evaluates their merits through the outcomes of the investigation.

Keywords: Building Collapse, Inspection, Pathology, Methodology

1. Circumstances

The collapse of a 25 year old office building in 1995 raised questions about the discoverability of the condition of a building and the risks inherent in re medial work. The failure to discover the errors in the original construction during the refurbishment of the building [1] resulted in the loss of the lives of the four people [2] working within the building when it fell down.
The court considered the liability of those who were involved in the construction of the building in 1969 and decided [3] that, 25 years after being responsible for the design and management of the original construction, Wickens Holdings were responsible for the loss of life even though they had engaged independent builders at the time the building was erected.

Fig. 1

The investigation [4] into the cause of the collapse revealed the limited value of the original drawings in determining the method of construction, the risk attached to buildings of this type, the problems caused because a collapsed building is not treated as a crime scene, the merits of a systematic deconstruction of the remaining building, and the benefits and weakness of the methodology used in the processes adopted.

2. Cause of Collapse

The investigation [4] revealed serious defects in the original construction around what had been the head or parapet of the former single storey building.
When the building was extended to three storeys, the lightweight concrete blocks forming the bottom course of the parapet wall were left in position for at least part of the construction and used to support the load-bearing columns at first floor level [Fig 2].
It was believed that all of the brick piers had been built on top of the 100mm wide concrete blocks that had formed the parapet to the roof of the single storey construction.
The collapse was caused by the removal of the lightweight concrete blocks below the windows at first floor level [5], leading to the sudden collapse of the five bays of the building. [4]

Fig. 2

3. Methodology of investigation

The investigation was carried out in several stages:

Static analysis

- A surface examination of the remains
- Examination of the drawings prepared prior to the original construction
- Consideration of Pathologist's evidence
- Examination of Aerial photographs

Dynamic analysis

- Deconstruction of the remains
- Testing materials
- Compare expected performance.

Verification

- Test the stability of the construction
- Model the construction for collapse
- Epidemiology
- Pathology

Determination

- Determination of collapse sequence
- Cause(s) of the collapse
- Determination of vulnerability to collapse
- Identification of lessons to be learned

4. Outcomes of investigation

There are a significant number of Buildings of a similar type that are still in use [4][6] As a result of the outcome of the investigation into the cause of this collapse a warning was issued concerning the risks attached to this type of construction [7]
Original construction drawings are not a reliable source of information about the method of construction or the materials that have been used and should not be relied upon without corroboration in the analysis of an existing construction [1] [3] [4] [6].
A structural appraisal should identify the vulnerability of such buildings on the following basis and recommend actions to be taken to reduce the potential risk.
Clients, planning supervisors, contractors and their advisers when renovating, refurbishing, extending or demolishing a building, particularly if the building was built before the Building (5th Amendment) Regulations 1970 took effect, should address the possibility that it may not be robust, and that damage to a key structural element could lead to a disproportionate collapse.[7]
The original developer of this site in 1969, Wickens Holdings, was found to be solely responsible for the death of one of the workmen [3][6] and ordered to pay compensation.[8]

5. Discoverability prior to collapse

The official report [4] stated that 'Examination of the brick columns still standing at first floor level showed no externally visible signs of the lightweight concrete blocks in the columns. They had been effectively hidden by the facing brickwork, internal plaster and the inclusion of infill brickwork. These defects at the base of the columns at first floor level could not have been expected and therefore the assessment methods could not have been expected to detect what had been constructed'

6. Methodology review

The data collected from the original construction drawings was incorrect – this was established from the inspection of the remains of the building. The recovery of material during the deconstruction of the remains of the building confirmed the weaknesses of construction that had been assumed during Data collection
The construction of a model and its subsequent testing confirmed the vulnerability of this type of construction to the loss of part of a single pier.
The Review process identified circumstances around the time of the original construction that suggested that construction at this time may not have been of the highest standard. .

References

[1] Hollis M. (2005) *Surveying Buildings* RICS London (p 487)

[2] Pathologists Reports of Dr N A Ratcliffe 3 August 1995

[3] Berwick v Wickens Holdings, John Lay & Co and RJ Watkinson & Partners January 2000

[4] '*Collapse of a Three-Storey Building: HSE Investigation Report'* (1999) Office of the Deputy Prime Minister London.

[5] Witness Statements 16 July 1996

[6] Bingham T. Building 18 February 2000 p67 *'Column Inches'*

[7] '*Ashford building collapse*: *HSE investigation report*' (26 August 1999). Office of the Deputy Prime Minister London.

[8] Contract Journal '*Weak structure claims four'* 1995 August 11

Diagnostic Protocol for planning and management of refurbishment interventions

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The control of the main factors affecting service life, as well as the management of feedback of data from practice become focal issues both to reduce performance decay and possibilities of breakdown and to guarantee improvement of building quality since the planning phase. Accordingly the research activity presented deals with the formulation of operational guideline based on a "System of Protocols" useful to operate at local level. The paper introduces one of the aforesaid Protocols: the Diagnostic one that defines a methodological proposal for building failures survey and performance evaluation. At now research team is involved in implementing and improving such Protocol and in performing some experimental applications finalized to verify, through real tests, its ability to forecast building performance behaviour during the time and its adaptability to different situations.

Keywords: Building Pathology, Diagnostic Protocol, Performance evaluation.

1. Introduction

It appears essential learning from the past and making use of all collected knowledge in order to allow an easy identification of defects, as well as to reduce failures incidences, and their effects. That represents the challenge and the commitment from research for years to come [1].
Briefly there is a twofold demand. On the one end, the definition of a careful approach for failures diagnosis, performance assessment and residual efficiency evaluation of buildings became needful. On the other hand, a tool, able to manage all available information, is highly requested for orienting choices in refurbishment intervention.
As response to these items one possible way it would be the introduction of a "system of protocols". Accordingly the research team has focused a general object dealing with the development of some experimental applications of the mentioned System. Mainly the object in the short time concerns the implementation and improvement of one protocol of the whole system: the Diagnostic one.

2. Background

The "System of protocols" is part of more general results of research activities financed by UE and developed since the '90s by the research unit S.T.O.A. (Science and Technique for Operativeness in Architecture) with the general purposing to formulate a Local technical guideline to managing refurbishment interventions [2]. The research unit makes use of La.M.A. – Laboratory of Materials for architecture that includes two different internal bureaus: the Departmental Documentation Centre of Materials for Architecture and the Mobile Instrument Laboratory.
Nowadays S.T.O.A. is performing some experimental applications of the previously defined diagnostic investigation procedure guidelines [3].
In this regard it has been formalized an important draft agreement with UNITEL – Italian National Organization Local Authority Engineer, and it is operative a joint effort with P.M.I. – Small and Medium Enterprises, thank to ILO – Industrial Liaison Office UNIRC University of Reggio Calabria too.

3. The "System of Protocol"

The operative structure of the "system of protocols" varies according to the intervention request and the context: each intervention will have its treatment "course-protocol". The whole system presents a strong flexibility in use and a good ability to be implemented. For each problem (question for an unsatisfactory condition), it can afford evaluation and control of degradation aspects and residual performance levels of existing buildings, detection of some specific constrictions, as well as opportunities to introduce materials and appropriate techniques. It has been structured according to a sequence of operational phases concerning 11 thematic evaluation protocols that define two specific aimed sections: Knowledge Program and Design Level. In particular Protocols n. 2, 3, 5, together with Protocol n 6, 7 and 8 constitute the "Diagnostic protocol".

4. The Diagnostic Protocol

This Protocol has been designed as a flexible tool providing guidance both for inspection phases related to failures and for following analysis, interpretation and comparison of data from practice. As well as a tool to support decisions in design phases taking into

account experiences from existing buildings and providing effective information to involved bodies like code makers, designers, contractors, and etc.
The ongoing research introduced is aimed to redefine the above protocol in order to make much more actual experiences in building failures survey and performance evaluation. It isn't a single oriented protocol; conversely results from an effective joining of some specific ones rising a strong flexible structuring.
A first combination, involving Protocols: P2 - *Genetic code evaluation* and P3 - *Building state evaluation*, is aimed at defining a 1st level *knowledge plan,* and giving back the information coming from the preliminary surveys; a second one concerning P5 - *Structure and risk evaluation*, at verifying the structural consistence state of building and the potential need for a normative adaptation. Moreover, the combination of P2 - *Genetic code evaluation*, P3 - *Building state evaluation*, P6 - *Material performance evaluation,* P7 - *Energetic compatibility evaluation* and P8 - *Hygiene and indoor safety evaluation*, is aimed at developing a 2nd level *knowledge plan* (according to results and needs suggested by the 1st level *knowledge plan*) in order to formulate an actual and correct diagnosis.
As previously said, this research goes by results of more general activities worked up by S.T.O.A., that make up, at now, an important and useful systematic collection of information concerning the knowledge of morphological and material characters of existing buildings, local constructive traditions, local environmental conditions, as well as individualization and evaluation of pathologies, knowledge partial joined in a building pathology database.
Particularly the above building pathology database refers to some analytical instruments like *Guide for analysis of Technical elements*, *Guide for Building Pathology survey*. All these guides are essential instruments enclosed in the *Codex of practice* for intervention in existing building arranged by research unit.

5. Results

At this moment our team has conducted only few experimental applications of Diagnostic Protocol; nevertheless Protocols in general and mainly the Diagnostic one, assume the role of a sort of structured memory list supporting and making easier the development of technical solution and related maintenance controls in refurbishment intervention. It makes able to enrich the factual knowledge about durability of materials and building element.

6. Conclusions

The fundamental purpose of planning is performing quality in construction and making easy to verify the work's performances over the time. Accordingly to what outlined by the forthcoming ISO 15686 Part 7 it's focal to guarantee improvement of building quality since the planning phase and predict service life, costs of ownership and maintenance of buildings too.
Although the overall normative attention and the high level reached by the scientific knowledge in the sector, it is still difficult to handle durability problems because of a limited number of systematic studies on service life prediction, and the lack of well-structured information. There is the lack of models and consistent and comparable data from the building stock describing deterioration processes and the influence of the environment. The research activity introduced is in agreement with the general assumption that the goal for the years to come will be enriching the actual knowledge about durability and the practical application of feedback from practice later during the design, the construction and the maintenance works. It is fundamental set up effective technical instruments and common procedures to all involved bodies from regulator and code makers, designers, producer, manufacturer, contractors and so on, in order to orient choice in intervention, and ensure quality and satisfaction of future usage needs.

References

[1] CIB Report W086 (1993) *Building Pathology. State of the Art*, Publication 155

[2] Nesi A. (2002) Normativa tecnica locale per il progetto dell'esistente premoderno. Strategie per il controllo tecnico delle azioni di recupero nei centri storici minori della Calabria, Gangemi, Roma.

[3] AA. VV. (2000/2006) *"Formazione, informazione e accompagnamento nella gestione dei processi di progettazione dell'esistente premoderno"*. Programma Operativo Plurifondo, POR Calabria 2000-2006 Misura 3.16, Azione 2 - Rafforzamento dei Laboratori Tecnologici Regionali sui Beni Culturali, Progetto MESSIAH – Sottoprogetto SPIDER

[4] ISO 15686 - 7 in progress Performance evaluation for feedback of service life data from practice

[5] Nesi Attilio, Lauria Massimo (2003) A Protocol System to intervene in Building Restoration, *2nd International Symposium on Building Pathology, Durability and Rehabilitation*, 6-8 novembre, Lisbon.

[6]Lauria Massimo, Azzalin Maria (2005) Building Pathology Database and Maintenance Approach in a well-defined context: Calabrian Historical Centres, *10DBMC International Conference on Durability of Building Materials and Components*, 17-20 April, Lyon.

The pathologies of the industrialized systems: 1.023 flats realized in Avellino in the '80s

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This report pays particular attention to the case of Avellino, not only because of the constructive system (buildings with structure in steel, floors made by "prédalle", carrying out staircase, and precast one layer infill panels, insulated on the inner side) but also because, thanks to a financing by the Region Campania in March 2001 and in February 2002 (just 15 years after the realization of the buildings), 604 flats of 7 districts are object of a program of building substitution. It has been found that the decision to demolish the buildings has been taken without conducting a deep analysis on the extension and the nature of the present pathologies.

Keywords: techniques of industrialization in building, steel and r.c. building system, floors made by "prédalle", precast infill panels, functional defects or anomalies, decay, failure cases.

1. Introduction

If you have to define a scale of importance and role played, in causing pathologic processes, by elements like *process*, *project* and *product*, you have to refer to the ILO – *International Labour Organization* hierarchy when it defines a priority between the definition of t*he methods of production* in respect to the *study of times*: the first being the *bulldozer* opening a track, and the second one the *spoon* finishing it [1], [2]. In fact, it's of great importance understanding if a productive process is conducted and controlled correctly to achieve quality objectives; where not, the obvious consequence of the process is that pathologies come out, expressed by characteristics of the project and product. In other words, we would state that *the main cause* of pathology may be the *process*, if not controlled under the qualitative point of view, even if disorders and pathologies may be the result of *specific errors in planning* or *executing* [3].

2. Avellino's prefabricated buildings

To demonstrate our thesis, it is particularly interesting the case of the 1.023 prefabricated flats realized in Avellino after the 1980 earthquake.
It was created a specific Authority – the Extraordinary Commissary – to manage, as for the technical and normative aspect, the procedure of rebuilding, by means of an "Extraordinary Office for Residential Building" – USER. In a first moment 55 milliards of Italian lires (i.e. € 28.405.129) were allocated, then 85 milliards of Italian lires (i.e. € 43.898.836), to build 1.000 "heavy" prefabricated flats in Avellino. The 20th of February 1981, the Municipality deliberates to award the contract of furniture to the two groups of firms classed first: VOLANI and FEAL Groups.
The works, started for the most part in the October 1982, actually have been finished with hundreds of even thousands days of delay. In the programmatic documents dated to the 18th of July 1997, it is considered the "*complete restructure of prefabricated building*" and the Regeneration Plan. Looking at the documents, you could realize a precise will to get rid of this 1.000 flats, having the prejudicial idea that they have serious pathologies and are not habitable. So the Municipality decided the demolition and substitution of 604 flats, after just 15 years since the end of the works of buildings.

This is a case study much more interesting than the English ones studied by BRE [4].

3. The principal defects attributed to the building realizations

Through the inspection of documents collected for a thesis degree [5] in the offices of the Municipality of Avellino, we elicited that, synthetically, the principals buildings defects of this intervention are ascribable to two categories:

- typological inadequacy: flats wrongly divided in comparison to the families requirements, and often too large in comparison to the dimension of the family nucleuses;
- technical pathologies, such us lifting and shattering of the floors, penetration of water from the roofing or from the loggias, superficial condensations, cracking and putting out of concrete protecting the steel rods in correspondence of the sitecast stairwell and of the precast infill panels.

4. The carried on analysis

We have provided to analyze on the one hand the general configuration of the different districts and the building blocks, their disposition in the respects of the

insolation and the views, the runs and the distribution, the organization of the different building typologies; on the other hand, the functional and maintenance characteristics of the different systems and sub-systems, finding out the present pathologies and their diffusion.
Analysis has been conducted in general on the whole intervention, and particularly on the Valle District, realized by the VOLANI Firm, that testifies the features observed in the average of the districts.

4.1 Evaluation of the spatial quality of the building

The study of the planimetrical organization of the districts, shows a distribution of building blocks "in-line" of different length and orientated in different directions, with casual disposition and influenced more by the form of the lots, than by considerations of exposure or sight.
The adopted typologies are for the large part constituted by large flats (m^2 69,13 and m^2 95,00 of clear surface), unsuitable to small family; but this drift from the choices operated by the Municipality in its *Building Program* of 1981. The typologies, characterized by a distinction "for face", introduce the day zone indifferently exposed toward the different cardinal points. Therefore, we cannot believe that bioclimatic criterions have been applied for the disposition of the buildings. Despite the double exposure, there isn't a transversal ventilation.

4.2 Evaluation of the technological quality

Using the methodologies set by the Committee W 86 in its *State of the Art Report*, we have carried on the analyses on all the subsystems. So it has been possible to appraise the efficiency of their performances and to individualize the presence of pathologies.
The result has been the verification of a good state of maintenance of the structures, both in foundation and in elevation. There are, as an exception, some (few) bases of pillars in the arcade, in correspondence of points were the footer is broken and meteoric water stagnates. Because of the lack of any specific protection, the primer of the corrosion is automatic, both for the presence of excessive damp and for differential aeration. The phenomenon is diffused at the intrados of the floors, at the conjiunction with the façades, in correspondence of the loggias, where the Z beams have a face against the throw in reinforced concrete and the other ones free. Here the corrosion for differential aeration is causing the appearance of the rust on the inferior flange of the Z, along the profile of contact steel-concrete.
The expulsion of the layer protecting the steel rods is a recurrent pathology. There are also many mistakes of planning.

5. Conclusions

The decision to demolish the largest part of the 1.023 prefabricated flats, built at Avellino, seems to have been, at least, so much hasty as the one to contract them, without knowing how and where building them. The *original sin* of the *process* makes *pathological* the *project* and the *product*.
The present pathologies are easily curable through interventions of programmed maintenance, thermal retrofitting with isolation from the outside, new external fixtures, change or substitution of the roof and its prolongation to the outside. Likewise it can be modified the layout of the flats and their dimension, that can be made smaller and suitable to the dimension of the family nucleuses. What cannot be done, at least with public money, is to judge affected by incurable pathologies the buildings, without submitting them not even to an accurate *medical visit*, equipped of *due analyses*.

References

[1] I.L.O. (1970), *Manuale di Studio del lavoro, dei metodi e dei tempi*. FrancoAngeli Editore, Milano.

[2] Lembo F. (2005), *Industrialized buildind typologies in public residential building and durability of materials and components. Research on some important interventions in Middle-South Italy*. Proceedings of the 10th International Conference on Durability of Building Materials & Components, Lyon.

[3] Lembo F., Marino F.P.R. (2002), *Il comportamento nel tempo degli edifici. Cause di degrado e soluzioni progettuali dei sistemi edilizi "tradizionali" ed "industrializzati". Casi di studio.* EPC Libri, Roma, 2.3, 61-72.

[4] Lembo F. (1988), *Qualità e conservazione nel tempo delle costruzioni industrializzate. L'esperienza inglese*. Recuperare, PEG SpA Editore, Milano, 1, 90-99.

[5] Placella G. (2002), *Studio delle patologie dei siti industrializzati attraverso l'intervento di edilizia residenziale Pubblica Sovvenzionata, realizzata ad Avellino nel periodo post-sismico. Località Valle*. Thesis of Degree Supervisors: Prof. Arch. Filiberto Lembo and Ing. Francesco Marino, Faculty of Engineering of the University of Basilicata, Potenza.

Durability of repaired concrete facade elements: design criteria, workmanship and testing

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This paper is based on the experience gained through a series of experimental investigations of the durability of repair work on reinforced concrete facade elements. These investigations centered on repair cycles using cement based mortars containing resin additives. It was found that repair cycles must be adapted to the situations encountered in each individual case. It is necessary, for example, to determine the properties of the concrete substrate, carrying out mechanical tests on samples. This procedure requires a significant investment in time and money, which will pay off in terms of repair quality. In addition, each stage of repair work must be correctly designed, and the methods for monitoring and inspecting repairs which are most appropriate from the standpoint of durability must be identified. The paper discusses the issues involved in specifying repair products and operating sequences, as well as their correlations with the new European standards for repair system performance testing.

Keywords: building recovery, concrete repair, facade elements.

1. Introduction

The large number of buildings featuring exposed reinforced concrete, these buildings' age, aggressive environmental conditions, and poor quality construction techniques have all combined to draw attention to the problem of deterioration in concrete masonry units and products, and to their repair, protection and maintenance.

Of the many chemical, physical and mechanical factors that affect concrete's durability, one of the most important is the phenomenon of carbonation in structures exposed to air, and thus to CO_2. The action of carbon dioxide reduces the concrete's alkalinity, and hence the protection which it affords to the metal reinforcement. In the presence of moisture, the reinforcing steel can oxidize, giving rise to further concrete degradation phenomena such as spalling, etc..

Concrete's durability has received extensive attention since the 1960s, with studies of the behavior and degradation of concrete, reinforcing metal corrosion, concrete carbonation, diagnostics techniques, repair techniques, and the durability of repairs. Technical guides have also been published, including those produced by the ACI together with the BRE and ICRI, while UNI EN standards have been issued for "Products and systems for the protection and repair of concrete structures".

2. The durability of repair works

This paper illustrates the major criteria for designing and performing repairs on reinforced concrete facade elements, as identified through experimental investigations of repair durability and work at a pilot site.

A number of fundamental aspects of repair work are discussed, including the need to understand the causes of degradation and the condition and characteristics of the area to be repaired, the need to develop a correct design procedure that specifies each stage of repair, and the need to identify the methods for monitoring and inspecting repairs that are most appropriate from the standpoint of durability. Several phenomena affecting durability are considered:

- The mortar's *drying shrinkage* after application, counteracted by the bond between the mortar and the existing substrate (assumed to be stable at any given temperature). This establishes a tensile stress in the mortar which will persist as long as the latter continues to adhere to the substrate.
- *Creep* phenomena, which help promote the system's stability by reducing the tensile stresses in the repair mortar.
- The repair material's *modulus of elasticity*, which must not be higher than that of the concrete substrate (if it is, repair mortar should absorb higher stresses, resulting in breakage or detachment).
- *The thermal expansion coefficient* of repair mortars, often similar to that of concrete. However, thermal shock on the mortar layer can cause excessive stress to build up as a result of shrinkage.
- Its *water vapor transmission*, in order to reduce interstitial condensation risk.

Other properties affecting repair durability include carbon dioxide diffusion resistance and surface water absorption.

3. Accelerated aging tests

A series of experimental investigations have been carried out at the Politecnico di Torino Second School of Engineering in Vercelli [1][2][3] together with the LTS laboratory (Prof. Tiziano Teruzzi, supervisor) at

DACD-SUPSI, Lugano (CH), and with the cooperation of a number of manufacturers in the sector. Through this work, accelerated aging tests for repair mortars were developed, product behavior was analyzed, and comparative tests were carried out on the basis of recently issued European standards EN 13687-2 and 13687-4. These are the results:

- Elastoplastic protective paint on the exterior surface significantly reduces microcracking and water permeability.
- The average mortar-substrate bond is good. Mortars also show high elasticity modulus and low vapor permeability, factors to be carefully evaluated to assure the compatibility of repairs.
- In certain cases, finish layer has a low pull-off bond strength, this too to be carefully evaluated.
- Application procedures are as crucial as product performances.

4. Repair works design and planning

The experience gained in the pilot site (facade repair of the Istituto Tecnico Agrario in Vercelli) indicated that the causes that led to degradation and the characteristics of the area to be repaired must be identified through on-site tests (depth of carbonation, reinforcing metal corrosion, modulus of elasticity, compressive strength, pull-off bond strength, etc.). The main stages of repair works are as follows:

- Selection of the products to be applied on the basis of degradation diagnosis and characteristics of substrate (modulus of elasticity, etc.).
- Preparation (substrate roughening and removal of deteriorated concrete and reinforcing covers, either mechanically or by hydrodemolition).
- Treatment of Reinforcing bars with corrosion-inhibiting passivating products. If necessary, reinforcing bars repair or replacement.
- Mortar application. If large surfaces and thick layers are involved, this is performed using mechanical spray equipment which uses either the dry-mix process, where dry mortar is driven through an applicator hose and water is added at the nozzle, or the wet process, where constituents are batched together before being fed into the delivery pump. Mortar can also be applied "by hand" in areas that the sprayer cannot reach (mortar must be protected in the first few days after application to prevent it from drying too quickly).
- A thin final layer of mortar is troweled on by hand.
- Elastoplastic crack-bridging surface protection is applied to retard carbonation and stop water penetration.

5. Repair monitoring and inspections

During work at the pilot site, it was found that it is essential to carry out tests on a sample area of the building before proceeding with repairs. This makes it possible to match repair methods to the specific needs, verify procedures, and make any necessary changes in product application. The following tests are carried out on the sample area and during final inspection:

- Checks during repair work, assessing substrate preparation, reinforcing metal cleanliness and passivation, the thickness of the applied mortar and mortar top coat, and the elastoplastic protective paint.
- Pull-off bond strength tests after 7 days (on the sample area) and after 28 days (final inspection).
- Karsten water permeability tests.

Particular care must be taken to ensure that the results of pull-off tests are *correctly interpreted*, i.e., that the position of the separation planes is borne in mind when assessing measured bond strengths. The values specified as minimum acceptance limits for pull-off bond strength tests depend on the properties of the concrete substrate and applied mortars, and are also indicated in SIA and EN standards.

6. Conclusions

The experience gained during work at the pilot site demonstrated the advisability of approaching repair projects case by case, analyzing the specific deterioration conditions, performing preliminary investigations, and planning repair work on an ad hoc basis for all stages, from selecting the products to be used to specifying application methods. To ensure durability, it is essential that the critical stages of repair work be monitored through on-site tests.

References

[1] Nelva R., Vancetti R., Frigeri G., Teruzzi T., (2003), "Elementi di facciata in cls armato: La durabilità delle riparazioni, sperimentazioni di invecchiamento accelerato", *Arkos*, Oct.2003, pp. 52-57.

[2] Nelva R., Vancetti R., Frigeri G., Teruzzi T (2003), "Durability evaluation for repair work on reinforced concrete", in *Management of Durability in the Building Process*, Maggioli

[3] Nelva R., Vancetti R., Frigeri G., Teruzzi T. (2004), "Metodi di valutazione della durabilità di tecniche di reintegrazione con malte di elementi di facciata in conglomerato cementizio armato", in: Sundry Authors, *Architettura e Materiali del Novecento*, Arcadia Ricerche, pp. 719-728.

Building knowledge as pathology knowledge: two emblematic cases in the city of Naples

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How materials an their performance deteriorate over time, the defects which gradually make themselves manifest, and its construction characteristics – original or otherwise – are fundamental factors for the comprehensive knowledge of a building. After drawing attention to the question of latent problems in buildings whose architects have opted for impromptu solutions or which have undergone unrecorded alterations during the course of construction, the authors of this paper go on to examine two emblematic cases, both of them concerning recent incidents and both in the city of Naples, in which only through detailed knowledge of their construction characteristics was serious disaster averted. This same knowledge now helps orientate work on their diagnosis and renovation.

Keywords: pathology, maintenance, knowledge.

1. Pathology and knowledge

Thorough knowledge of the construction methods of a building is of particular importance for the correct management of the building, especially when it comes to diagnosing the pathologies that gradually arise over the course of time (many of which can be predicted, in terms both of their nature and their frequency of occurrence), correctly scheduling maintenance work to bring the performance of the buildings components above the minimum pre-established thresholds, and making an accurate assessment of the building's useful life. Experience has shown that in many cases the explanation for a pathology is closely connected with the technical properties of a certain building component or the manner in which different components have been assembled during building work [1]. From this derives, obviously, the importance of knowledge as an essential instrument in what is frequently a problematic diagnosis process. The problem obviously assumes greater relevance in the case of buildings erected without codified building rules, where their designers – engineers or architects – employed unconventional building solutions, or where unorthodox expedients were adopted during the course of construction, either because the builders wanted to, or because they had had to.

2. The importance of records

Ever since the earliest studies on scheduled building maintenance it has been realized that maintenance cannot properly be scheduled without a detailed case history of the building Here, however, theory has always been at odds with reality:

- while it has been obligatory to file for planning permission in Italy since 1942 (planning act no. 1150), many of the older records in local government archives are far from complete, and in some cases have been destroyed;
- while a law (no. 1086) of 1971 made it obligatory to officially deposit calculations on structures in reinforced concrete, prestressed concrete and steel, in reality the necessary figures are not always available, as attempts to obtain them during inquests into disasters, for example, have shown;
- the obligations imposed by the legislation cited above totally fail to make allowance for the alterations so frequently made during the course of building work – alterations which are often significant in their scope, and which effectively leave us confronted with two different buildings, with different floor plans and volumetrics, an extra column here or a column missing there, different foundations, and different layouts.

And all this is not to mention so-called "spontaneous" construction – buildings which are erected illegally, without any form of supervision, and subsequently legalized or in the process of legalization via diverse expedients, occasions on which engineers are faced with the impossible task of issuing an assessment even on the building's static profile, something of which their knowledge can only be extremely limited.

But such a situation must not detract from the importance of studies designed to demonstrate the importance of keeping records: of building techniques, of defects, of diagnoses and of repair or renovation work, so that all these records can be systematically cross-referenced using a clearly-defined, methodological approach [2]. Similarly, it only serves to underline the importance of the array of controls imposed by the body of legislation on scheduled maintenance, insofar as this legislation includes the obligations to compile "identity cards" for buildings: we refer primarily to the framework law on public works, but also to the various initiatives of more local character, addressing building documents and building maintenance handbooks.

3. Two emblematic cases

So much for the merely theoretical exposition of a principle – albeit one which finds widespread acceptance. But the theory is substantiated every day by reality, by many cases which amply illustrate the great advantage of possessing detailed knowledge of the buildings we live in, so we can avert what are often serious dangers. From so many possible cases we have selected two, both in the city of Naples. Both of these buildings are remarkable for the "strangeness" of their construction methods, and both illustrate the potentially drastic consequences of insufficient knowledge of these methods.

The first building is located in the city's Materdei quarter and was recently affected by the partial collapse of its roof terrace during routine maintenance work on one of its top-storey apartments. What happened was the following. The building firm, like others before it, had assumed the roof terrace to consist of a reinforced concrete slab carried on reinforced concrete beams. In reality, however, the structure was more complex, comprising two slabs, an upper and a lower, with a beam sandwiched between them. The reinforcement bars in the beam, in the middle section, were embedded in the lower slab, and attempts to remove this slab ended up disrupting the stability of the structure to which it belonged – thereby compromising the integrity of the ceiling. Repair work is now underway in the building, with the area affected by the collapse being reconstructed with a new steel frame; the other two apartments on the top storey are receiving stabilization work.

The other building is in the Vomero quarter. A few years after maintenance work, a number of deep cracks began to appear in various places around the windows of this building. Some time later, a large scab of plaster came loose from the 4th storey of the building's main façade. Investigation revealed that the building had originally been constructed with 4 storeys of masonry and 3 of reinforced concrete, with no provision made for the adequate distribution of loads. This explains the absence of cracks on the 5th, 6th and 7th storeys, and the gradual diminution in the occurrence of the cracks from the 4th storey down to ground level. This building is now undergoing stabilization, partly with traditional techniques and partly by stiffening the floor with composite materials (unidirectional carbon fibre fabric nailed to pultruded rods and glass fibre-reinforced structural plaster).

4. Conclusions

Observation of real cases, whose consequences can often be dire in terms of damage to persons and property, further underlines the importance of full and accurate knowledge of the construction characteristics of buildings. This knowledge is particularly valuable when it comes to:

- arriving at an accurate diagnosis of the causes of observed defects, which can often be traced to the original construction methods/characteristics of the building or the renovation work it has since received;
- scheduling building management work during the building's useful life, to ensure that the performance of the building's components meets and exceeds the required levels;
- conducting an accurate assessment of the building's durability.

In all events, notwithstanding the great variety – and unpredictability – of the construction methods found in buildings (especially buildings from the first half of the 20th century), the authors maintain that this only makes it still more important to keep records of building methods which can be correlated with the corresponding records of recurring pathologies, diagnosis, and intervention.

References

[1] Croce S. (1994) *Patologia edilizia: prevenzione e recupero,* in Manuale di progettazione edilizia, Bema, Milan.

[2] Nicolella M. (2003) *Programmazione degli interventi in edilizia – Guida al libretto di manutenzione del fabbricato*, *UNI,* Milan.

[3] Croce S. (1988) *Progetto e Durabilità*, Modulo, Bema, Milan, no. 140.

[4] Lee R. (1976) *Building Maintenance Management*, Blackwell Scientific Publications, Oxford.

[5] Molinari C. (1990) *La manutenzione edilizia*, F. Angeli, Milan.

[6] Maggi P.N. (2000) *La qualità tecnologica dei componenti edilizi. La durabilità*, Epitesto, Milan.

[7] Maggi P.N. (2001) La qualità tecnologica dei componenti edilizi. La valutazione della durabilità, Epitesto, Milano.

The requirement approach and the art's rule

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The present study reports advancements and results obtained from the application of the requirement approach in the reading of the Building System as teaching method as well as testing of the technological planning. It is to be shown that theoretical understanding of this methodology may shape the art's rule. In order to satisfy the user's requirements and to tackle the complexity of ensuing topics, it is necessary to consider the building as a complex system that can be analyzed in different ways, coordinated by the same method, depending upon aims to be attained.

Keywords: Requirement method, Art's rule, Teaching method, User, Building System.

1. Introduction

The implemented methodology, applied to technological planning, has been worked out from UNI Standard 8289/81 [1] that states the classes of user's requirements; whose defined subclasses allow identification of specific topics relative to the building use. The building has been analyzed as a complex system, known as the Building System. However, we have formulated specifications different from those reported in the Literature [2]. Such specifications are referable to the ambits in which solicitations act and allow analysis of identified topics. Reference to the Building System specifications has required reflections upon the identification of the Building System units.

Identification of performance requirements as a consequence of problems expression (performance requirements and problems always to be considered from a methodological point of view since it is meaningless any exhaustive listing) drives the performance evaluation of the Building System units as well as of products contained within it and underlines the analysis of the in situ behaviour, as requested by the Construction Products Standard [3].

The outlined methodology can be also referred to topics derived from the statement "following the art's rule".

In Italy, this statement, found in several documents used in the building process for manufacturing a construction work, involves assumption of responsibility with juridical implications. In the absence of specific references, it is important to underline that the requirement approach applied to the study of the Building System may contribute to the identification of performance requirements and to the evaluation of performances of technological solutions, no matter how complex they might be, to be utilized in the works. Thus, the statement "following the art's rule" would imply not only a juridical meaning but also a technical meaning and of appraisal evaluation.

2. Building as a system

The Building System is considered the building thought as complex system.
Analysis is developed into three phases:

- the first with reference to the whole of data needed for planning which has to be transformed in planning drawings;
- the second with reference to the whole of users' requirements and to System Building's specifications;
- the third with reference to the whole of relations of the System Building's parts linked together.

The first step is to study the consequences provoked by solicitations on the Building System and on users and ensuing reactions. It is of particular importance the study of how happen phenomena affecting the building and, particularly, it is necessary to individuate the spatial ambits in which phenomena occur and unravel the relationship agent, action, effect [5]; it is also necessary to know users, i.e., sex, age, social conditions, carried out activities, etc., in order to unravel hypotheses concerning users' behaviour models. In this framework, it is possible firstly to analyze activities in a specific fashion and in a given environmental context, and secondly to identify problems to be studied in relation to planning solutions.

3. The requirement approach and the Building System

The next step is to establish a relationship between results of the first analysis with requirements classes contained in UNI Standard 8289/81. In fact, the Building System, as a complex system, can be con-

sidered as the spatial ambits targeted to satisfaction of users requirements.
In order to satisfy the user requirements, it is necessary to articulate even more the requirements classes listed in the standard. Verification of real implementation of what is deemed necessary (requirements) stems from the comparison between values prescribed by the performance requirements and those measured in the real situation (performances).
Identification of performance requirements must take into account knowledge of phenomena which occur inside and/or outside the building, causing effects on it, and as a consequence, on the user, and of answer to some key questions concerning effects on the building. Thus, understanding consequences of solicitations on the building and on the user requires specification of the Building System that allows identification of ambit of study of phenomena pertaining to the building and of ambit of study relative to parameters of measurement and evaluation that drive planning.
As a function of the analysis ambits, it is proper to consider every time the Building System from the technological, environmental or functional/spatial viewpoint; as a result of this approach, there will be an articulation of the Building System in Technological System, Environmental System or Functional/Spatial System. Thus, the Building System can be also defined as the ensemble of ways to study the building as a function of the aims to be pursued or, in other words, the ensemble of reference ambits where phenomena occur and planning parameters are evaluated and measured, and for each of them, performance requirements that satisfy the requirements are identified. Thus, in order to make possible analytical studies of effects provoked by phenomena and the evaluation of implementation of planning parameters within the reference ambits, it is necessary to identify reference physical units. Any articulation of the Building System can be considered an ensemble of units, so that there will be technological, environmental or functional/spatial units. Identification of these units allows the specification, for each of them, technological, environmental and functional/spatial performance requirements. Performances can also be specified in technological, environmental and functional/spatial performances.

4. The art's rule

The locution "art's rule" means "well executed" and has juridical foundation that corresponds to multiple technological solutions; in order to provide technical content, it is necessary to prepare reference planning indications, known as conform solutions, referred to specific functional schemes.
Transition from conform solutions, intended as ensemble of elements and of functional layers [4], to the specific technological solution which involves expression of layout, requires transposition into technical specifications of contract. To this aim, it is necessary to identify precise performance requirements that, in our contention, can be identified by the requirement approach.

5. Conclusions

Adopted methodology is based upon the requirement approach; it needs articulation of the Building System in study ambits because it allows identification of specific performance requirements, i.e., technological, environmental and functional/spatial performance requirements. This approach allows to control that technological solutions, examined in situ, fulfil identified performance requirements. Examination of data relative to the environmental context, of the influence of phenomena and of relative consequences on the building, and analysis of users and their reactions, constitutes the first phase of the adopted methodology; expression of users requirements and specification of the Building System constitutes the second phase; evaluation of the relationships among Building System specifications, and, consequently, identification of planning priorities, leads to the choice of technological solutions and to verification of their performances and constitutes the third phase.
Therefore a very precise relationship is established between technological solutions and "art's rules".

References

[1] UNI 8289:1981. Edilizia. Esigenze dell'utenza finale. Classificazione.

[2] AA.VV. *Performance 1 / La metodologia del performance design*, in Parametro n° 7, 1971.

[3] 89/106/CEE-Direttiva del Consiglio del 21 Dicembre 1988 relativa al ravvicinamento delle disposizioni legislative, regolamentari e amministrative degli Stati Membri concernenti i prodotti da costruzione.

[4] UNI 8627:1984. Edilizia. Sistemi di copertura. Definizione e classificazione degli schemi funzionali, soluzioni conformi e soluzioni tecnologiche.

[5] ISO 6241:1984 Normes de performances dans le batiment. Principes d'établissement et facteurs à considérèr.

Quality and deterioration of the architectural concrete facades

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The objective of the research is to give the basis for a rationalization of the technological knowledge about the employment of the architectural concrete, to improve the technique to restore the architectural quality that force the preservation today, and to give back to the concrete technology its innovative gift for the architectural growing. The research work intends to fill the gaps of connecting instruments between cultural strategies and technical choices and to supply with operating tools.

Keywords: architectural concrete, durability, pathology, restoration, operating tools

1. Introduction

In the last decade attention has been drawn to the need to coordinate the architectural project (and its formal, functional and technological features), with the operating plan, and organizing, economic and financial phases of the project. The management and the planning of maintenance are become very considerable most of all owing to the pressing concern of previous situations of decay (more and more evident and urgent) and on account of the acquisition of European directives concerning the theme of maintenance, furthermore because of the growing interest in the property value increment by maintenance and renovation. The requirement-performance approach, basis for the maintenance-management project, is become an integral part of the building process, as the main instrument of quality evaluation of every single product abd of the system as a whole, imposing a univocal interpretation of the decay and the "performance decline", as a pathologic condition to make up. It often happens that the surface decay springs from poor quality of concrete, incorrect mixtures, wrong installations, an inadequate management of the building yard, employment of unsuited formworks and too much stressed structures, that cause the develope of more or less superficial crackings. On the other hand the problems of this kind of surfaces are derived from polluting outer agents and exposures to chemical weapons, closely connected with imprecise installations (as the lack of an adequate iron covering).

2. Architectural concrete

When we request an aesthetical performance from the concrete, this material has to warrant stability and structural durability qualifications, but has also to guarantee the superficial finishing that the designer wants to obtain. The possibility to get geometrically perfect surfaces without flaws, or deliberately irregular, to obtain facades that maintain unalterable their chromatic characteristics, or look older by nature as stones, is the essence of the architectural concrete, that can assume countless shapes and superficial appearance.

If on one hand, in fact, we can define the architectural concrete as a structured surface, with foreseeable shapes, superficial appearance and colours, on the other is true that in the fulfilment of an architectural concrete many factors can modify the final outcome, but are absolutely not predictable or checkable for a certainty (like the atmospheric humidity, or the installation). For this reason the designer has to know to a very depth all the elements that concur in fixing the final appearance of an architectural facade, to be able to select and measure out the correct quantity and proportions of them.

We can synthesize into five principal categories the factors that contribute to obtain an architectural concrete of quality:

- The morphology and the dimension of the designed elements (tightly connected with the ageing of the material and to the reaction to the atmospherical agents);
- The complementary and instrumental materials (formworks, forms dismantlers, reinforce bars and spacers);
- The concrete's components (cements, aggregates, water, additives and misture of them);
- The installation (casting, vibration, seasoning and protection);
- The outer agents (weather and polluting substances)

3. Pathology of architectural concrete facades

Variations of the colour, spots, efflorescence, stains, cracks, detachments are only some of all the problems (more or less checkable) that could compromise the employment of this kind of material and exactly the multiplicity of this defects induces us to talk about a pathology, in the accepted meaning of Sergio Croce.
For this reason is basic to analyze carefully all the phases of the process to avoid, shorten and, in case, rectify the deterioration of the aesthetic perphormances, because of on this case it is more considerable than the mechanical (when they doesn't coincide) or thermal performance. A conscious planning of the shapes with the objects of preserving the cleanliness in loaded with dust, atmosphere humidity and pollution substances, is closely connected with the aging and the exposure to the outer agents.
The concatenation of the above-mentioned five factors could determine the pathology of the facade.
Most of defects, in fact, both endogenous one and exogenous ones, could be avoid (or anyway restricted and shortened not to come to a pathological situation), by adopting some precautions at the beginning of the process, both in designing phese (of the facade and the mixture), and in installing and protecting phase.

4. The restoration of architectural concrete facades

The restoration of architectural concrete façades find expression in consolidated operations, even it is necessary to pay attention to all the phases of the reclaiming , because every intervention can have peculiar characteristics with the consequent need of specific solutions. For example if we intervene, in case of detachment, by filling with mortar like the original one, we can pledge the structural performance, in many cases the aesthetic result disappointed, because the retouching is to evident owing to the different condition of seasoning (the final touch is usually marked out by a darker colour, so is very difficult to hide it completely). In the same way the choice to clean surfaces by means of products that remove the superficial film of mortar changes remarkably the original appearance of the facade.

5. Conclusions

The result of the research was the setting up of a dynamic, integrable and adaptable (on the specific requirements of the different operators) operative tool, consisting in synoptic schedules about:

- typology of possible surfaces, preceded by diagrams that made clear the relations betwen the different types of possible texture, and followed by a photo record office;
- typology of possible defects, preceded by a synthesis diagram cause/effect, followed by a photo record office with details of the pathology and the explication of the compromised appearance of the whole building.

This work is conceived as basic systematized knowledge, basis for following computerization of data (in databases), to realize a consulting and integrating instrument, adaptable on the different necessities of the varied implicated operators, and to warrant a updatable development of the resurch.
This instrument could be adopted by a new professional figure, we can call "techno-pathologist", absent today, in possession of the instruments to adequately evaluate the pathologic state of a material or structural system (in this case architectural concrete) and to make a correct diagnosis.

References

[1] AA.VV. (2001), *Cim beton."Bètons apparents",* collection Technique Cimbèton, Parigi.

[2] Adam, M. (1975), *Aspetti del calcestruzzo. Tecniche, realizzazioni, patologie*, C.E.L.I., Bologna.

[3] Croce S. (2003), "Patologia edilizia", in *La qualità edilizia nel tempo*, Hoepli, Torino

[4] Di Giulio R. (2000), *Manuale di manutenzione edilizia*, Maggioli, Rimini.

[5] Mehta P.K., Monteiro P., *Concrete Structure, Properties, and Materials*, Prentice-Hall, N. Y. 1994.

[6] Neville A.M., *Properties of concrete*, Pitman, New York, 1980.

Proposal for a sustainable recovery planning

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Restructuring and preservation work on historical buildings and structures has become more common in the past years. This increase in the number of interventions on existing buildings has created a demand for new theoretical and technical developments to sustain environmentally sound project strategies. Such strategies should avoid any transformation that alters the structure's character, and should encompass the preservation of the structure's original typology, construction, and functionality. In addition, in these strategies the principles of sustainable architecture should be incorporated. The objective of this research is to carefully analyze the life cycle of a restructuring or preservation project, to ultimately determine the strategies that improve the internal and external qualities of the buildings. If sustainability of a building means to minimize the impact on the environment, this methodology becomes a requirement in order to implement strategies that limit the use of energy in the process of restructuring or preservation.

Keywords: sustainable, recovery planning, life-Cycle Assessment (LCA).

1. The problems of the energetic

The situation puts into effect evidences them as the problems of the energetic consumption deriving from not renewable sources and of the excessive gas emission to effect greenhouse are more and more serious and need of searches and coherent and organic strategies of application between they. The demand for energy, in fact, has grown in last the one hundred years in exponential way, implying problematic series is for its supplying - from the wars to the important political-economic implications to world-wide level - is for the atmosphere (atmosphere, waters, land, air), with consequences for the man and the ecosystem. It is necessary, therefore, to make important reflections in every productive field, on one side in order to reduce drastically the consumptions and from the other in order to replace the traditional sources of fossil origin with those alternatives. In the field of the building, two fundamental obstacles to the application of criteria of energetic saving are present on immense scale. The first one is the economic factor that, in absence of favorable mechanisms, often enters in contrast with the realization of particular technologies. The second regards the constructive tradition: the climatic factor comes normally omitted, leaving the burden of the attainment of objects you of comfort often acclimatizes them only to the mechanical action of the systems, omitting the member covering.

2. Restructuring and preservation work

Also the culture of the participation on the existing must necessarily hold account of the situations acclimatizes them to the aim to favor a constructive art that can be defined sustainable development.

Restructuring and preservation work on historical buildings and structures has become more common in the past years. This increase in the number of interventions on existing buildings has created a demand for new theoretical and technical developments to sustain environmentally sound project strategies. Such strategies should avoid any transformation that alters the structure's character, and should encompass the preservation of the structure's original typology, construction, and functionality. In addition, in these strategies the principles of sustainable architecture should be incorporated. These include: sound exploitation of resources, temperature and lighting comfort, ventilation, solar radiation, and finally the use of low energy cost materials. Hence, these intervention strategies must consider the existing environmental conditions in order to promote a "construction art" that can be deemed sustainable.

3. The main scope of the search

The main scope of the search is to deepen thematic relative to the planning the echo-sustainable. Just based on the appraisals carried out, considers the building activity as one of the fields more high impact acclimatizes them, through the consumption of the territory, the high energetic consumption and the emissions in connected atmosphere to it. It is chosen to face problematic the inherent ones to the study case through the methodology known to international level with the name of Life Cycle Assesment (LCA), that is the analysis of the cycle of life ("from the crib to the tomba") of of a city within pertaining to the complex of the Former House of the Jesuits of Catania estimating of the advantage obtained from the recovery, regarding the demolition and reconstruction. Such method concurs to estimate the impact acclimatizes determined them from the product during its cycle of life and allows moreover, to identify the opportunities of improvement of the echo-compatible characteristics of the product and therefore its competitiveness on the market. The search, is coming true in the within of an agreement between the University of the Studies "Catania and the ENEA (Agency for the New technologies, the Energy and the Atmosphere) of Bologna, by means of the code of Dutch calculation Sima For 5 whose it turns out to you, has been analyzes to you through three methods: the method Eco-Indicator 99, method EPS 2000, the method Edip 96.

References

[1] Brundtland,G.H., 1987 *Il futuro di tutti noi, Rapporto della Commissione mondiale sull'ambiente e lo sviluppo*, Mondadori, Milano.

[2] AA.VV., 1981, *Riuso e riqualificazione edilizia negli anni '80*, F.Angeli editore,Milano,.

[3] McDonough, W., Braungart M., 2003, *Dalla culla alla tomba. Come conciliare tutela dell'ambiente, equità sociale e sviluppo* , Blu edizioni,Torino

[4] AA.VV. 2000, *Costruire sostenibile*, Alinea, Firenze.

[5] Du Pont,P., Morrill. J, 1989, *Residential Indoor Air Quality & Energy Efficiency*, ACEEE, Washington.

[6] Baldo G.L., 2005, *Analisi del ciclo di vita LCA, Materiali, prodotti, processi,* Edizioni Ambiente, Milano

[7] Forlani M.C. (a cura di), 2001, *Costruzione e uso della terra*, Maggioli Editore

[8] Cangelli E., Paolella A., 2001 *Il progetto ambientale degli edifici*, Alinea Editrice, Firenze

[9] Manzini E., Vezzoli C., 1998 *Lo sviluppo di prodotti sostenibili*. I requisiti ambientali dei prodotti industriali, Maggioli Editore, Rimini

[10] Antonini E., *La sostenibilità*, in Sinopoli N., Tatano V. (a cura di), *Sulle tracce dell'innovazione tra tecniche e architettura,* Franco Angeli

[11] Pulselli R.M., Tizzi E., 2003*La ricerca di un'architettura sosteni*bile, in Abitare la Terra. La rivista per la nuova alleanza tra l'uomo e l'ambiente,

[12] Gallo C. (a cura di), 2000 *Verso un libro verde per l'edilizia sostenibile. La qualità energetica e ambientale dell'edificio,* ENEA, Roma

[13] Castelnuovo L:, 2001, *Il rispetto dell'ambiente,* in: *Il bioprogetto*, BE-MA Editrice, Milano

[14] Luciani R., Andrioli L., 2001 *Sviluppo di prodotti e processi ecocompatibili*, ENEA

[15] ITACA – Gruppo di Lavoro Interregionale in materia di Bioedilizia, 2004, *Protocollo Itaca per la valutazione della qualità ambientale di un edificio,* Relazioni e documenti, Roma

[16] Allen G., Moro M., Burro L., *Repertorio per i materiali della Bioedilizia,* (a cura di) Anab (Associazione Nazionale Architettura Bioecologica), Maggioli Editore

[17] Cappellaro F., *Introduzione alla LCA*, (2001) Doc.ENEA OZ-SCA-00005 Bologna

The degradation of plasters in historical buildings: Lungarini (formerly Settimo) Palace

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The paper describes the pathologies of plasters of the historical buildings in the area of Palermo, Italy. The analysis is carried out starting from a restoration intervention on Lungarini Palace, still going on. Work on the building started after the earthquake of September, 2002, thanks to a public program for the restoration and conservation of the monuments. The restoration operations, at the beginning, have been concentrated on the main façade, which showed degradation and large failures in many areas, caused both by building defects (the edifice has been transformed along the centuries due to the changing distributive needs) and by the absence of manteinance. The examination of the plasters have been carried out in parallel with the consolidation of the brickwork, that are constituted by big ashlars of tuff at the ground floor, and a kind of 'sack' brickwork at the noble and cadet floors. The main facade of Lungarini palace shows a double layer of plaster, one with a decoration with false bosses and another with flower ornaments. This layer belongs to the first XV century paint. The second layer is from the baroque period.

Keywords: Buildings pathologies, plasters, historical buildings,baroque

1.Hystorical-architectural events

Palazzo Lungarini is placed in the Street by that name in the historical center of Palermo, in a site rich in important historical landmarks. Via Lungarini, a curving urban artery, characterized by numerous aristocratic residences, connects the Marina plain with Alessandro Paternostro street, and terminates in a widening shaped by the fifth rebuilding of Lungarini palace, residence of the noble Settimo family, later Abbate of Lungarini (XVI and XVII century).

Fig.1- The site near the ancient Cala port

In spite of its unified aspect, the palace looks like an enormous palimpsest, like a manuscript rewritten over several centuries. Like the majority of Palermo historical mansions, it is the result of diverse embodiments, of medieval or perhaps late medieval origin, all collected in an imposing "baroque" design of decorations, both internal and external.

A careful study of the monument shows a series od widespread pathologies and degradation, which can be mainly attributed to the lack of maintenance. The building was also affected by continuing processes of transformation, adaptation and subdivision: as we shall see, these caused a partial vulnerability in the structural unity of the complex. The start of a consistent program of intervention [1] aimed at protection and maintenance was necessitated by a seismic event that took place in Palermo in September, 2002. The paper will describe the pathologies and historical degradations of the wall plasters, on the basis of that professional experience: a unique learning opportunity for the author, who conducted it.

2. Plaster layers in the Baroque facade

The outer aspect of Palazzo Lungarini was changed radically in the 1700s, in order to provide the building with a baroque-style facade, as was done to the other ancient mansions of the period. The main characteristic of the palace, indeed, is the front prospect, 42 m long, subdivided in three great span, which together form a powerful, rhitmic composition. On that prospect, the many stories contained in the building can be gleaned, by reading the stratigraphy of the plasters; during the structural reinforcing, the graffito decorations from the 1600s, in the "noble" floor, came to light, as well as some architectural elements (windows, arches) of the preceding medieval or late-medieval structure.These features emerged here and there, in those parts of the prospect where the superficial plaster was lifting. Each of these decorative fragments, proof of a highly advanced ornamental technique originating in the 1500s (to simulate stone wall) shall constitute an ensemble of icons, "newly found" and "recomposed" in a coherent representation, which will express the overall image of the prospect. This image, at the same time coherent and rich in emerging stratifications, must be preserved in its integrity and formal quality.

3. Establishing the alterations

The building exhibited, in the baroque prospect, a series of degradations and deformations, due to widespread structural problems, affecting all the structures. This situation was enhanced by the earthquake from of Semptember, 2002; but the series of pathological conditions can only in part be determined from the plastering of the baroque facade along Via Lungarini, the lamdmark element of this historic Palermo mansion. The degradations in the plaster are due, in part, to the structural dislocations, with diverse characterizations (fissures, diffuse lesions, etc); in part, to the poor maintenance of the whole complex, as well to natural agents (water, wind, etc), both extending over time, and occasional. As a matter of historical certainty, Palazzo Lungarini has seen numerous seismic stresses, such as the Palermo area earthquakes of 1726, 1823, 1940, 1968; more recently, near the end of 2002. These stresses have caused differently characterized damage (erosion, alveolizzation, fissuring...).

fig. 2 Degradations. Particular of the scracth ashlars below the balcony of the second floor

Indeed the causes of degradation of instability have always been many and contemporaneous, and then the possibilities for their combinations are practically infinite. This is one of the many reasons that suggest us to repeat and underline the criterion that any building is a particular case, and that is impossible to collect in a single document all the possible causes of degradation of all the materials that are present in the building industry as well as preservation techniques.
The paper shows the more recurrent alterations through the analysis carried out on the study of the principale facade, which will be used for the elaboration, according to the instruction of the Normal Commission, of a complete picture of the most common phenomena.

4. Interventions

The fundamental operation to drive the restoration interventions was the composition of a survey of the mortars used in the masonries and in the realization of the plasters of the facades of palazzo Lungarini. The project indeed wants to preserve th existing material – the various layers of plaster and the finishings – and the new 'scialbi' – can represent technically essential additions, light and thus not totally covering to allow, when possible, the reading of the manteinance intervention. In particular the following mixtures have been found:

1. A mortar made of lime paste, sand and inert materials used to paste the unshaped stones of the bearing walls. In some cases it was observed the presence of inert material from the shattering of bricks and stones fragments into the mortar.
2. Mortar made of lime paste, sand and marble powder used for the facades plasters.

The main facade shows a plaster layer of about 3-4cm.; the powder from the shattering of the cut stone gave the plaster characteristics similar to the stucco as well as waterproofness; for this reason, it was used in the facades and in the common areas.
In other cases mortars made of two binding agents made of lime and plaster cast together with an inert material. In the design phase the same traditional building techniques are reproduced using the same materials and components. The restoration will certainly imply the protection and the consolidation of the existing plaster because it is an hystorical document and because it is still quite resistant. After having executed the consolidations and having decided what areas of the graffito plaster must be set into light, a 'scialbatura' is carried out; indeed the design of a superficial protective plaster constituted of sand and natural colours is considered fundamental for the preservation of the underlying part. The underlying plaster is then consolidated in the detouchments and restored In those areas which cannot be repaired with mortars suitably chosen in function of the features of the existing materials.

References

[1] Restoration project (1994-1996): Architect: G. De Lisi, G. Di Benedetto, M. D. Vacirca; Structural project: arch. G. De Lisi; Director (2004): architect R. Riva Sanseverino

Building pathologies in social housing: the Portuguese state of art

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During the XX century, a great intensity of new buildings construction was occurred, representing these buildings an enormous patrimonial valour, which require a permanent investment in management, maintenance, repair and rehabilitation. To provide adequate qualitative and quantitative levels of housing, great economic investments have been made in social housing, what implies the necessity of realise a study on the physical conditions of the built public housing park, with the aim of knowing about the necessity and viability of rehabilitation interventions in order to achieve quality and durability. Rehabilitation investment in the built environmental, beyond contributing for the preservation of the existing patrimony, contributes for the implementation of construction sustainable politics, through the reduction of the consumption of natural resources and energy, of the reduction of residues proceeding from the construction activity and for one better management of ground occupation. In opposition to this, has been registered a quality and durability decrease of the public and private built environmental through its precocious degradation. The aim of this paper is to identify the principal anomalies which appear in portuguese social housing buildings, based on a bibliographical research. This work aim to find design and construction solutions with a minor durability, to be eliminated in future projects.

Keywords: social housing, anomalies, deterioration state, durability, rehabilitation.

1. Introduction

The deficient quality control in the construction of social housings, the absence of studies on the global cost of the buildings and of the respective degradation models, as well the absence of maintenance planning, was expressed in the lack of durability and in the precocious and accentuated degradation of these buildings. Associated to these factors, the aging of this housing park and the lack of the economic resources necessary for its maintenance and rehabilitation had aggravated its physical degradation that is still more serious than in the private sector. An important aspect to have in consideration, ever in new construction ever in any intervention on the built environment, is to give the privilege to durability and easiness of maintenance in opposition to the low initial cost of the construction. By other side the rehabilitation of the built environment is essential to get housings with good conditions, so it must be promoted techniques that conjugate the cost-effectiveness and the durability of the interventions.

To reach this relation must be established clear commitments since the planning, design and construction phase, through the chosen of materials, systems and processes that allow the performance waited for the users, as well easiness of repairing or substitution, when necessary [1]. On the other hand the characterization of the main anomalies that occur in the buildings, allows the identification of the less efficient solutions and the consequent elimination in future projects.

2. Anomalies in social housing buildings

In Portugal the recognized lack of durability and quality of the social housing, associated to absence of support programs to its rehabilitation takes that a high number of these buildings presents different levels of degradation, with the consequent urban and social degradation [2]. These parks managing entities need instruments that allow them to identify the intervention necessities in a priories form and which results, support their decision about the intervention to effect. For these instruments elaboration it is necessary to characterize the type of anomalies that affect these buildings, so a bibliographical research has been done and presented hereby.

The diversity of social housing programs realized along the years, have had as result a great diversity in dimensions, typologies, housing standards and degradation state [3].

In the analysis of the behaviour of the applied rehabilitation solutions to 32 social housings sets, constructed in the north of Portugal, with a total of 4200 lodgements, has been done a study about its envelope behaviour, special in the external walls [4]. These set of buildings was subject to rehabilitation operations in its envelope – roof, external walls, frameworks, joint zones, drainage facilities. Before these works have been identified as more frequent anomalies: walls coatings crakes and penetration of rain water inside the lodgements; the aging and detachment of waterproofing material in the joint between the framework and the wall; the lack of mechanical resistance of the brick cover in the warping; the degradation of the rain water drainage facilities; the lack of elasticity and consequent crack and detachment of the waterproofing material in the expansion join between buildings; dampness in the interior of the ceilings of the higher lodgement, because the lack of waterproofing layer in the roof. After the rehabilitation it could be observed the incidence of similar anomalies. It would be essential that must not persist too much short cycles of rehabilitation/degradation, through the guarantee of the durability of the found solutions, contributing itself for the increase of the economy of the interventions and for the environment preservation. On the other hand it is necessary that the rehabilitation interventions decision, to be taken in these buildings, must be based on studies that guarantee the satisfaction of specific levels of performance, the solutions durability, the consequent increase of the service life, the reduction of maintenance and repairing interventions, the introduction of systems, components and materials that contribute to facilitate any future intervention.

The National Laboratory of Civil Engineering has been done the retrospective analysis of the social housing park financed by the National Institute of Housing, having in the 3rd Analysis [5], relative to the years of 1995 to 1998, done an inquiry to the residential satisfaction in which, in respect to the lodgement the inquired had shown no satisfaction, nominated about the exterior sound isolation, the isolation of windows frameworks and doors, and to the temperature and ventilation of the house.

Relatively to the evaluation of the building the inquired had shown no satisfaction, among others items evaluated, relatively to the exterior aspect of the building, to the building construction materials and to the conservation state of the building. (in interior and exterior walls and ceilings), 8.7% to problems in water distribution nets, 6.8% to problems in the nets of sewers and 38.4% to diverse damages ([5], adapted from Table 8: 243).

Of the entire analyzed studies, stand out the incidence of anomalies in the buildings envelope, which degradation degree must be identified and characterized. These anomalies often imply the appearance of several problems in the interior of the lodgements, with the consequent decrease of the habitability quality and of the inhabitant's satisfaction.

3. Conclusions

The results of the referred studies strengthen the importance of proceeding to the characterization of the degradation degree of the constructed social housing park, in order to justify the options for design solutions and for rehabilitation, in which it must be privileged more durable materials, systems and installations, with minimized and facilitated maintenance and guaranteed safety at work. So it is essential the guarantee of quality rehabilitation proceedings in which durability will provide a new image to the existing buildings, so important for the valuation and preservation of the constructed housing patrimony.

To determine this degradation degree it is necessary to establish an objective method, from which it is, attributed a graduation to the buildings and/or its elements and components that allow taking priories decisions on the type and depth of the interventions to take place in the building. The durability and consequently the life cycle cost of the building is strength related with the degradation mechanisms, being essential the determination of the degradation degree to decide itself about the actions to implement. Thus, to fulfil with requirements specification of the users, and with the components functions the building have to comply, having in account the factors that influence this performance, it can be identified possible degradation mechanisms and the respective effect, and establish degradation indicators, which work is in development.

References

[1] NAHB Researcher Center, 2002. Durability by Design. A Guide for Residential Builders and Designers. http://www.huduser.org/Publications/PDF/durability_by_design_part1.pdf, [05/11/11].

[2] SEH (2004). *O Sector Habitação no Ano 2003*. Ministério das Obras Públicas, Transportes e Habitação. Secretaria de Estado da Habitação. Lisboa. Janeiro, 2004.

[3] Cabrita, A. R., et al. (2000). *Gestão Integrada de Parques Habitacionais de Arrendamento Público – guião recomendativo*. LNEC. IORU. Lisboa.

[4] Abrantes, Victor et al. (1999). *Reabilitação de Edifícios – Estudo do comportamento e análise técnico-económica das soluções utilizadas nas obras de construção e reabilitação*. IGAPHE – DGHN – FEUP. Porto.

[5] LNEC (2004). 3ª Análise Retrospectiva do Parque Habitacional Financiado pelo INH anos de 1995 a 1998. Relatório 239/04 – NAU. Laboratório Nacional de Engenharia Civil. Lisboa.

Performance decay for maintenance actions: continuous roofing systems case

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The frequent employment of environmental cameras, able to simulate the external agents actions, particularly climatic and environmental agents, by means of artificial aging tests, enable to take the performance decay of the inquired technical element (or of its components). So that it is possible to organize the performance-time diagram of the same element. The aim of the paper is to underline the performance deficit of the analyzed element, visible in different performance threshold and measurable with destructive and non destructive tests and to individuate the maintenance interventions for the reinstatement of the performance levels of the technical element. Particularly, it is important to define the time limits to which the different performance decays and related decay state definition correspond, before analyzing the possible anomalies, detectable on the investigated element; the following step is to determine the maintenance activities correspondent to the obtained performance deficit. The treated argument will be illustrated in an experimentation on continuous roofing systems, with particular reference to two technical solutions, different for the last layer: the one type with a slating, the other with a acrylic varnish.

Keywords: technical element, performance decay, maintenance, continuous coverings

Building pathology: survey, diagnosis and maintenance planning

Building pathology studies "procedural, human, environmental, technical, technological, physical, clinical (disturb factors), interactive actions which cause, in close times, physical and performance changes of a building element (…) There is a pathology when decays (physical and performance) happen in temporal and qualitative terms, accelerated and contrasting with conventional concept of natural ageing (…)" (Cib W86 definition). Generally, before appearing of breakdown, that compromise the element functionality, or its components, anomalies can present themselves having to be interpreted to plan maintenance activities[1]. The objective of the diagnostic survey is, on the one hand, to allow the individualization of causes, responsibility and ways of the breakdown development; on the other hand, is to support the definition of maintenance, recovery, restoration. Starting from the geometrical and technological survey, moving through the survey of breakdown estate and of performance decay, through the visible anomalies survey, and the diagnosis phase, the plan of maintenance actions to do during the years concludes the operative iter.

The environmental chambers

Climatic and environmental conditions are able to influence the behaviour of materials. With reference to the building field, there are many chambers able to reproduce the action of several external agents; the principal typologies are reported as follows: climatic chambers, dry corrosion test cabinet, sun simulation chamber. All the tests are executed according to the national and international regulations. With reference to the climatic chambers, available for use in D.IN.E., Building Engineering Department, University of Naples Federico II, it is able to simulate natural external agents, that can be found easily in a meteorological year: temperature changes, sun rays, with a xenon lamp, relative humidity. Concerning to the research about continuous roofing system, three cities as a sample have been choose (Milan, Naples and Palermo) that have three climatic context that are very characteristic on a national scale.

Anomalies survey and diagnosis: the continuous roofing system case

The treated argument is applied to continuous roofing systems , particularly with reference to two examined technical solutions, that are different for the last layer planned: the one type with a slating, the other with a acrylic varnish. Having said that, to determine the operative protocol aimed to the survey of performance decays, we have proceeded to a systemic exploration of all the possible technical solutions of continuous roofing systems detectable on the national territory. After the phase of definition of technical solutions, we have proceeded to the plan of the specimens that have to be examined. Evaluated the more representative technical solutions, defined the natural agents, that can be simulated with the climatic chamber, planned the specimens that have to be investigated, the final step is to do the ageing tests which underline the performance decay, associating to the any temporal limit maintenance actions, that correspond to the analysed performance decay: 1. anomalies that highlight defects e/o breakdown, directly on the element on which appear; 2. anomalies that highlight indirectly defects e/o breakdown on other non visible parts. With reference to the examined technical solutions, they point out anomalies detectable directly on the external layer (first case), and anomalies that concern the membrane directly (second case). The anomalies detectable on the acrylic varnish layer are: degradation of the protective layer, that is the degradation of the superficial layer with exposition of the membrane to the action of external agents. This anomaly, caused by physiological obsolescence, atmospheric agents (rain, sun rays), aggressive atmosphere, execution defects, water disposal system defects, induces performance decays connected to the aspect, the functionality of the varnish layer, without scoring the functionality of the waterproof membrane. The most important anomalies detectable directly on the membrane layer are reported as follow: bubbles and reinflating, crocodiling, superficial fissures and craquelures, chemical-physical degradation, ageing, desegregation and, detaching of superficial elements, detaching of returns and sormonti, breaks and crackings, crackies and corrugamenti, unstickings, detachements, partial and general dislocations of the membrane, undulations, elevations of the membrane, superior vegetation. Bubbles and reinflating, due to the action of atmospheric agents, to changes of temperature, to production and execution defects (non realization of staircases towers for the evaporation of the water in the of the base of the roofing system), evidence the presence of water in the underlying layers of the roofing system. The chemical-physical degradation, with ageing, desegregation and, detaching of superficial elements, due to the action of external agents, atmospheric agents, changes of temperatures, atmospheric contamination, chemical products, can express aspect defects, and functionality of the technical solution. Unstickings, detachements, partial and general dislocations of the membrane, with exposition of the membrane to the action of the atmospheric agents, due to execution defects, can provoke performance decays connected to the aspect, security, functionality. Undulations, elevations of the membrane, particularly recurrent along sormonti and returns, and due to the physiological obsolescence, atmospheric agents, bumps and traumatic stresses, production and execution defects, different deformability of materials which come into contact underline defects connected to the aspect and the functionality of the waterproofing membrane, because, in this case, the occurrence of fissures and, in more serious cases, of rents along angle joint is frequent. Finally, the superior vegetation, with, as a consequence, the development of plants roots, due to the action of atmospheric agents (rain, wind) and to the spontaneous formation of birds nests, with performance decays connected to the aspect, to the functionality of the waterproofing membrane, defects of the rainwater disposal system, can reveal a non suitable resistance of the same membrane to the root action [4]. Particularly, with reference to the membrane with a slating, superficial alterations consisting in gap of the slating layer, due to the non suitable adherence of the granule to the base, may take place.

Conclusion

The programmed controls and interventions, and, more precisely, the considered execution frequency, are inserted in a maintenance planning which underline the temporal limits of all the maintenance actions that have to be done on the examined technical elements, during a reference period. The construction of the performance-time diagram, for each investigated element, is functional to the definition of the temporal limits to which maintenance actions have to be done, in the more wide ambit of the building maintenance plan, according to the current regulations

References

[1] AA.VV., Manuale di progettazione edilizia Fondamenti, strumenti, norme, Vol. III: Progetto tecnico e qualità, Parte III, Cap. II (S. Croce) - Vol. IV: Tecnologie – Requisiti, soluzioni, esecuzione, prestazioni, Parte prima Cap. 8 (F. Forteleoni), HOEPLI Editore, Milano

[2] AA.VV., Impermeabilizzazioni: coperture continue, codice di pratica, BE-MA Editore, Milano

[3] IMPER Italia S.p.a., Impermeabilizzazione ed isolamento termico – Schemi esecutivi

[4] Nicolella M. (2003), Programmazione degli interventi in edilizia - Guida al libretto di manutenzione del fabbricato, UNI, Milano

[5] UNI 8090 - Elementi complementari delle coperture. Terminologia

[6] UNI 8290 - Edilizia Residenziale – Sistema tecnologico – Classificazione e terminologia

[7] UNI 10838 - Edilizia – Terminologia riferita all'utenza, alle prestazioni, al processo edilizio e alla qualità edilizia

The correct use of marble and stone in cladding: the BIAN.CA. Project.

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The use of marble and stone in cladding requires deep knowledge: some examples show problems due to their incorrect use and send a message of complexity and there is the need to know their behavior. The BIAN.CA. Project, concluded in Massa Carrara by IMM, suggests a survey of the preservation of buildings realized with Apuan Alps' white marbles, to create a data base with a schedule realized by the major local companies. It was difficult to create it, but however the result was an efficient tool of analysis, useful in the future to focus the problems and to face them.

Keywords: marble and stone, claddings, correct use, BIAN.CA. Project., IMM

1. Introduction

The marbles and the stones are very traditional, precious and fascinating materials, they are deeply linked to our building traditions and perfectly adapted themselves to the processing and building technological evolution through the centuries. The stone materials' most significant application in architecture is the use in external cladding, that requires deep knowledge of them and of the more advanced anchoring technologies too, in order to obtain correct results through a conscious design.

There are, in fact, a lot of examples that show the problems due to the incorrect use of the stone materials, such the Finlandia Hall in Helsinki, the Amoco Building in Chicago and the Grand Arche in Paris. These projects send a message of failure, of excessive complexity, and of risk too, of the application of stone materials in the façades and in the envelope's systems, but around the world there are a lot of examples of buildings built using marbles and stones that had no problems during decades and a lot of projects that have been recently realized in the correct way. There is, then, the need to know the real behavior and resistance of marble and stone in such utilization, to address the choice of the materials by the designers and by the contractors, with the strategy to increase the value of the services offered by the companies in this sector.

2. The BIAN.CA. Project

The BIAN.CA. Project, recently concluded in Tuscany Region in the province of Massa Carrara (that with the province of Lucca forms the stone Industrial District) is a Regional project: BIANCO DI CARRARA Environmental safeguard through correct use of external claddings. The programs that supported this project are the DoCUP Objective 2 2000-2006 (Measure 1.7 "Transferring of the innovation to the PMI") and PRAA 2000-2006 (Action D21 "Actions of system for research and innovation"), proposed by IMM-Internazionale Marmi e Macchine Carrara S.p.A., that also organizes Carrara Marmotec, an important fair in the stone sector. The objective of the Project, entirely coordinated by IMM, is to prevent the use of some types of Carrara marble that in external claddings loose their mechanical characteristics and have to be removed and substituted with costs' increases and problems of image. This objective was quite the same of the one of the projects MARA and TEAM promoted by European Community, that didn't achieve satisfactory results. The BIAN.CA. Project suggested to realize a schedule, to be publicized among all the actors of the building process, which defined the information to acquire to consider the parameters that influence the behavior of the cladding. Using this schedule the Project provided for a very detailed and deep action of survey of all the buildings realized in the last years with Apuan Alps' white marbles, of their state of preservation and of the possible intervention of substitution of some slabs and panels. All the information collected in this way would be used to create a wide and flexible data base, useful for all the statistic and technical studies in necessary in the future to define the problems and their causes. The objectives of the BIAN.CA. Project in detail were:

1. Create the net of the partners and involve more companies;
2. Coordinate the work;
3. Implement the scheduled activities;
4. Individuate the subjects to be involved in the next phases of the research;
5. Realize an executive program for the next activities of research;
6. Realize and actuate a plan of diffusion of the objectives (at the start) and of the results (at the end);

3. The organization

The partners involved were coordinated by IMM as leader and they were chosen among the major local stone companies and, with the contribution of their technical consultants (among them the author of this paper), had the task to analyze the problems of the use of marble in external claddings and to realize a complete and exhaustive schedule in order to run the survey. These companies were Adolfo Forti Marmi S.p.A., Barsimarmi S.a.S., Bertozzi Felice S.r.l., Co.ge.mar S.r.l., Corsi & Nicolai S.r.l., Euromarble S.r.l., Ezio Ronchieri S.p.A., Henraux S.p.A., La Facciata S.r.l., Marmi Carrara S.r.l. and Savema S.p.A.. The technical staff of IMM organized a series of meeting in order to proceed to the drafting of the schedule, considering all the different aspects of the problem, seen from different points of view. These meetings were very important especially for the exchange of experiences that were very different according to the dimension of the company, of its management and of its technical office or consultants, to the specialization in the quarrying of particular materials or in the trade in specific markets, to the processing techniques and to the existing job contacts with big and important architectural studies and societies of engineering around the world.

4. The schedule

The first part of the schedule deals with the site of the building and with its prevalent weather condition, in order to know if the possible problems come from an incorrect choice of the material according to them. Then are requested information about the building and the project, to exactly visualize the way the stone was used and to establish a direct link with the designers, not straightly included among the partners. The second part of the schedule is about the general information about the material: it is very important to know the technical characters to focus the possible cause of the problem. Very significant are the petrographic definition according to the norms (EN 12440), in order to avoid confusion and to exactly define the type of the marble, and the possible tests according to EN, UNI, ASTM or other norms. An important aspect is the possible material of support (honeycomb, alucobond, glass or carbon fibres, epoxy resins, steel). Very important are, then, the dimensions (especially the thickness) of the slabs, the modules, the processing and the surface treatments. The third part of the schedule is about the type of the façade and of the structure of the building, the typology of system and of anchorage, the material and the model, if it is built in industrial way, the type of the connection to the structure and the position on the slabs. Very important is to know who made the assemblage because an incorrect one can nullify all the previous operations. These information about the anchoring system are significant because in the past it was one of the weak points of the façades for the use of wrong materials and the not industrial production. In the last part of the schedule are described the problems and the action taken to try to solve them. The schedule is also completed by drawings of the buildings, schemes of the anchoring system and of details of the anchorage.

5. Conclusions

The BIAN.CA. Project started in February 2005 and ended in July 2005 and in the last phases the staff of the IMM and the partners of the Project couldn't fill in a significant number of schedules because of the very low consideration given in the past to these aspects of the organization of the building process. The expected data base couldn't be organized, but however the Project led to a very important result with the realization of this schedule which collects the experience and the professionalism of IMM and of important companies in the Apuan area, known in the world as the centre of quarrying, processing and trading of stone materials. This schedule represents the vitality of the entire Apuan industrial area and its intention to react to the crisis of the sector: it is a very efficient tool of analysis, probably the first ever predisposed in this direction, and it has to be diffused, in prestigious occasions like this Symposium too, to create real competences among the designers and a new culture of the stone. Waiting for these future developments, the schedule it is very useful for the survey of new buildings, in order, in the next years, to create a real data base of the problems related to stone claddings, to focus and correctly face them.

References

[1] Acocella A. (2004) *L'architettura di pietra. Antichi e nuovi magisteri costruttivi.* Alinea Editrice, Firenze.

[2] Detail 7 (2001) *Facades* Institut für internationale Architektur-Dokumentation, München.

[3] Detail 11 (2003) *Building with stone* Institut für internationale Architektur-Dokumentation, München.

[4] Fioraso M. (2004), *Facciate a secco. Aspirazione progettuale e realtà dell'installazione., Atti del convegno "L'involucro edilizio: innovazione e sostenibilità",* Fiera del Levante, Bari.

[5] Lucchini A. (2004) *Evoluzione delle pareti ventilate: sistemi e materiali, progetto e messa in opera., Atti del convegno "L'involucro edilizio: innovazione e sostenibilità"*, Fiera del Levante, Bari.

Rising damp in historical buildings: A serious building pathology

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The study of the restoration of historical buildings is becoming increasingly important, both because of the need to encourage the conservation of architectural heritage, and because of a heightening awareness that this activity is very interesting for planners, builders and researchers. This means that the number of scientific studies involving pathology and restoration is also growing. If we analyze the pathologies observed in historic buildings systematically, we find that rising damp is a serious problem. The purpose of this paper is to systematize the problems caused by rising damp in historic buildings and the techniques for treating them. At the same time, it confronts the problems that still face us today in terms of dealing with rising damp with research that has been developed in an effort to minimize these problems.

Keywords: rising damp, historical buildings, building pathology.

1. Introduction

Any action taken on built heritage today requires a thorough, objective understanding of the exact situation involved.
The multifaceted activity of carrying out interventions on architectural heritage is tending to embrace a growing number of specialities, and there is a clearly growing need for a deeper knowledge of the causes of the many problems that afflict old buildings, and of the possible treatment solutions.
The overwhelming need to adopt the best methods and solutions requires extra investment in the preliminary study phases, before the intervention, and in the meticulous choice of the best technical solutions to be used in each situation.
In the past, one parameter that had to be borne in mind when choosing where to site major buildings was proximity to water lines, to ensure easy supply. This has meant that today damp is one of the leading causes of deterioration in historic buildings, with rising damp being one of the commonest manifestations, but one for which the treatment is most complex.

2. Treatment of rising damp in historic buildings

Walls with problems caused by rising damp can be treated by any of the following technologies:

a) Execution of a damp-proof course;
b) Creation of a potential against capillary potential;
c) Installing atmospheric drainage/ventilation pipes;
d) Applying coating with controlled porosity and porometry;
e) Hiding the anomalies;
f) Ventilation of the wall base.

3. Wall-base ventilation: experimental and numerical validation

Ventilated peripheral channels should be dug outside and/or inside the affected walls when there is lateral infiltration, that is, when the depth of the wall is greater than the maximum depth of the water, since it does not completely prevent capillary suction: it merely reduces it. By making trenches round the affected walls, lateral infiltrations are prevented, on the one hand and, on the other, water evaporation inside the trenches is significantly increased. The depth of the trenches should never be greater than the depth of the foundations, for safety reasons.
Although this is not a new technology, it has neither been used very much nor studied scientifically in order to validate it/find its scientific dimension.
Laboratory of Physics Constructions at the University of Porto has carried out experimental and numerical studies to help ascertain the efficacy of this system.
The selected physical model consists of a prismatic system measuring 1.58 x 2.00 x 0.20 m3, waterproofed on the two top sides to prevent moisture in this direction, with walls made of limestone slabs measuring 30 x 20 x 200 cm3, with 1 cm thick lime mortar joints.

Table 1 - Different boundary conditions

Configuration 1	The second gap is filled with sand
Configuration 2	A forced ventilation system is placed at the base of the wall

In configurations 1 and 2 we measured the behaviour of a wall with both sides underground by placing sand on both sides of the wall up to a height of 45 cm above its base.

In configuration 2, since we wanted to assess the effect of placing a ventilation system at the base of the wall, we placed a ventilation box on both sides of the wall. We left two openings to which we attached flexible tubes to ventilate the box. We attached a mechanical extractor at one opening and left the other one free to allow air to enter freely (Figure 4). This extraction system was left running for the duration of the test so that we could make sure the temperature and relative humidity inside the box were identical to the conditions we had in the laboratory.
The following main conclusions were drawn from the experimental research:

- Placing a ventilation system at the wall base is a good technique for reducing the level of rising damp.
- After the experimental study, one question remains: is the wall thickness a problem?
- The automatic calculation programs to evaluate changes in the moisture content and temperature inside walls are essential instruments in simulating the wall's behaviour in the presence of humidity, depending on the internal and external climactic conditions. The automatic calculation program used in the numerical simulations was WUFI-2D, developed in the Fraunhofer Institute for Building Physics.
- The experimental campaign was limited to considering a single wall, 20 cm thick, but Portugal's ancient building can actually have walls up to 1.00 m thick. A series of numerical simulations was thus performed to find the behaviour of walls of different thickness.
- Maintaining all conditions apart from wall thickness, two separate situations were simulated:
- A wall buried up to 45 cm of its base;
- A wall buried up to 45 cm of its base, but with its base ventilated such that the conditions of relative humidity and temperature inside the ventilation chamber were identical to those of the respective exterior environment.

As expected, the level reached by the moisture front increased as the thickness increased. It was further found that when the ventilation system was placed at the base of the walls, the moisture front decreased.

4. Conclusions

The main conclusions are as follows:

- In historic buildings, the traditional techniques for treating rising damp are not effective;
- Ventilation of the base of walls (0.20 - 1.00 m) is a simple technology that offers great potential;
- The varying thickness of the walls (0.20 - 1.00 m) has a slight influence on the efficacy of the wall-base ventilation, but the improvement in the functioning of the wall after the introduction of the ventilation system is clear.

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References

[1] Torres, M.I.M.(1998) *Humidade Ascensional em Paredes*. Msc-thesis., FCTUC.

[2] Torres, M.I.M.(2004). *Humidade Ascensional em paredes de construções históricas* PhD-thesis. Coimbra, FCTUC

[3] Torres, M.I. and Freitas, V.P.de.(2003) *Rising damp in historical buildings Research in Building Physics*-Proceedings of the 2nd International Conference on Building Physics, Leuven, Belgium, pp 369-375

[4] Freitas, V.P.de.(1992). *Transferência de humidade em paredes de edifícios* PhD-thesis, Porto, FEUP.

[5] Torres, M.I. and Freitas, V.P.de.(2005) *Treatment of rising damp in Historical Buildings:Wall base ventilation* in Building and Environment, accepted for publication

[6] Torres, M.I. and Freitas, V.P.de.(2005) *Wall Base Ventilation for Rising Damp Control in Historical Buildings: Research and Practice* in Proceedings of the 10th Canadian Conference on Building Science and Technology, Ottawa, Canada, pp174-183

Quality in vulnerability assessment of existing R/C structures

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The structural safety assessment of the existing buildings is strictly related to the prevention and the maintenance management problem, mainly for buildings that, like R/C and masonry buildings, cannot be considered as "eternal" any more. Unfortunately, the quite uncommon practice of inspecting the existing structures with a regular schedule and the lack of skill in detecting the incoming structural damage make the residual safety level assessment more difficult and rough. The safety assessment problem is becoming more and more important, as proved by the publication of the Italian OPMC 3274 (2003). In fact, these recent national technical guidelines suggest to evaluate the safety reliability of strategic existing buildings of first and second class seismic areas. The proposed assessment method is based on the general evaluation of the building real conditions and introduces into the structural computation some confidence factors depending on the knowledge level. In fact, the recently published "Technical Guidelines for Constructions" (DM 14/09/2005) specifies that: "the quality guarantee, control and quality plans are essential tools in order to evaluate the construction structural reliability". It is thus very important to make engineers and field operators aware of the problem, to improve their technical knowledge by means of a systematic interdisciplinary approach founded on the careful examination of the residual technological performances of the considered structures, because a sound prevention of structural deficiencies is strictly dependent on that. To complete the paper a study case is presented herein. The study case is is a viaduct known as "Fornello" of the Italian highway Orte-Ravenna (E45).

Keywords: Quality, Management, Control, Vulnerability, Existing R/C Structures

1. General and regulatory organization

The matter of ascertaining the state of conservation of existing buildings is a very topical one: recent statistics indicate in fact, that the number of buildings which due to age or various other conditions, show structural problems connected with the degradation of the materials, is extremely high. News items in recent years, concerned with the tragic collapse of buildings provide evidence of the reliability of these appraisals, confirming that the problem of structural safety requires particular attention to be paid to prevention and maintenance, especially for concrete structures, which are no longer "eternal" like those made of brickwork masonry.

If until recently, restoration and structural consolidation were considered practices typical of monumental constructions, from now on it is necessary to recognize the problems connected with work (repairs and replacement) on reinforced concrete structures.

By-law 3274/03 states on the other hand the requirement to carry out reliability checks for structures of strategic interest situated in seismic zones 1 and 2.

The method of checking introduced for existing structures assumes a general survey of the situation and introduction into the calculations of confidence factors depending on the level of knowledge of the existing structure (LC1-LC3).

In this respect it has to be stated that there are valid methodologies for measuring the factors which determine suitability for use of constructions with reference to retaining the initial requisites of the materials and therefore the safety margins prescribed by the building regulations. Ministerial Decree 14/09/2005 specifies in this regard that *"quality assurance, checking and quality plans are essential tools for assessing the reliability of structures",* which is consistent with the performance guidelines of the most modern regulations.

Therefore, the search for tools suitable for representing the status of existing buildings and structures becomes opportune when there is a need to check their structural status for withstanding earthquakes; however, this is a complex task due to having to express the variables which must be codified.

In the majority of cases structural degradation is due to inappropriate structural design as well as being under attack from the external environment: after the condition of the materials has been carefully ascertained as well as all the characteristics of the structure, it is necessary for the engineer to identify the minimum essential characteristics which must be present in order to be able to claim that the safety and functionality of the structure are guaranteed. Once it has been asserted that these are present, then a numerical analysis has to be carried out under the actual conditions found, which procedure proves to be the final part of the study process, as opposed to the vast extent of the preliminary ones.

With these premises the systematic organization of the checks completed for ascertaining structural safety cannot leave aside the concept of maintenance since through this it is possible to check over time the problems connected with structural degradation, thanks to systematic observation of the status of the structure.

Life in service connected with the “concrete factor” can be achieved effectively in reinforced concrete structures, provided that once service life starts, the quality of the concrete is not compromised in any way and provided that the risk factors taken into account at design stage do not undergo significant change over time.

Factors responsible for negative variations in the local properties of concrete can originate from:

- the complexity of architectural choices;
- adopting working practices unsuitable for the specific application;
- the use of unsuitable components;
- environmental factors.

At all events, the ideal composition of concrete for structural uses must be such as to provide a material with reduced permeability. The most frequent variables which condition durability are therefore:

- the presence of holes due to inadequate compacting in the form;
- the formation of shrinkage fissures;
- reduction in the thickness of the concrete cover to reinforcement.

By monitoring the structure it is possible to slow down the degrading phenomena in a timely manner when there are no flaws in the working drawing or gross design errors. What is more, the same restoration works which may be initiated, since they are carried out on damaged or defective materials, must be monitored over time.

Maintenance awareness is recent and therefore we have inherited a considerable legacy of buildings with reinforced concrete structure which have not been checked for decades and which were created at times when the concept of structural safety, especially with regard to being earthquake-proof, was very different from what is meant today.

At the current state of knowledge designing according to a given service life does not permit excluding from what is already known the need to have to carry out maintenance work for the purpose of maintaining the functionality planned. Moreover, the same C.S.LL.PP. “guidelines for structural concrete” from 1996 in point 7.2 claim that “*The service life is the time during which the structures and/or materials must maintain their performance, while maintaining the operational level of safety and efficiency of the design for any action and environmental condition foreseen, except for routine maintenance”*.

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Inspection and appraisal of old buildings. Building defect reports for the rehabilitation process

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In what concerns large renovation programs of old city centres, choosing the most adequate approach for inspection, appraisal and diagnosis is a complex task that can determine the success or the total failure of the project purpose. This paper describes the procedure used for the inspection of 700 buildings located in the old city centre of Coimbra (Portugal). In this paper will be presented the building check-lists developed for inspection, the building defect reports produced for the rehabilitation and renewal process.

Keywords: Historical city centre, building defects, diagnosis, inspection and rehabilitation.

1. Introduction

There is growing evidence that built heritage conservation carries benefits in many areas the urban environment. Responsible decision makers, institutions and authorities involved in urban development programs have recognized the urgent need to preserve their cultural resources and assets, and moreover to relate cultural values to development. In the area of construction, it has been estimated that 50% of all building refurbishments in European cities relate in some way to heritage preservation [1]. The physical refurbishment of historic city centres provides the means for social revitalization of communities and neighborhoods, economical attraction and improvement of the quality of life.

2. Methodological approach: Old city centre of Coimbra

The renovation process of the old city centre of Coimbra is a national singular experience on urban renovation and rehabilitation. Other Portuguese cities have started and still ongoing renewal actions, but have not undertaken the renewal process in such an organized, integrated and methodological manner. In order to survey and study the old city centre area, the project perimeter was divided into eight zones (big city blocks). Each zone includes several buildings that share in many cases the same type of architectural, functional and occupational characteristics to be inspected and analysed with the purpose of in a final stage each zone is studied and renewed as a whole. In the scope of the renovation and rehabilitation process, the city council invited the University of Coimbra to carry out a complete identification and inspection survey of the buildings on three different domains: (a) architectural typologies, (b) constructive and pathological condition of buildings, and (c) socio-demographic characterisation, of this part of the city.

Four teams of inspectors where created, three of them for each aspect mentioned above, and a fourth team to create a computer data-base to manage, inter-cross and analyse information gathered, using SIG platform and a DBMS. The interaction between teams with different interests but with some common final aims is a decisive factor to contribute to a final and balanced solution. It will only discuss the second aspect mentioned above, related to deterioration and defects of buildings under the engineering point of view. This first stage – a complete inspection and identification survey – is the solid basis of the process and it is essential to acknowledge all variables and sensibilities involved, so that further stages, like the definition and proposal of various base-projects, correspond to building features inspected and identified. All this information individualized and recorded for each building in the computer data-base is a tool to promote and justify decision making and help develop in the future rehabilitation projects individually or globally in a larger scale – city block project.

3. Survey and appraisal of old buildings

The survey is the starting point to assess and identify the condition of the buildings and their defect analysis investigation. Survey actions are often inadequate and unfruitful, because they are not based on a true knowledge of the building stock, from the type of materials used, construction techniques, typical defects, etc. A poor survey can have a negative effect influence on the way the building is discussed, managed, compromising its future well-being.

Choosing the most adequate approach for inspection, appraisal and diagnosis is a complex task that can determine the success or failure of the project purposes. This problem is particularly important when it is intended to inspect more than 700 buildings in 18 months range, with a good level of accuracy and coherence to achieve reliability set of data.

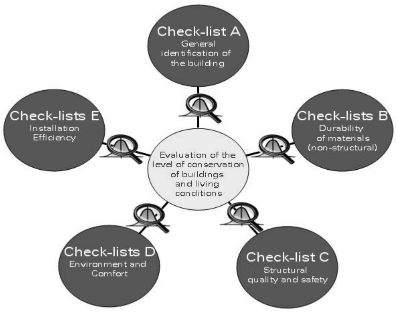

Figure 1. Check-lists for building inspection

To achieve these objectives, only a very few number a buildings could be revisited, what should happen only in the most dramatic or suspicious situations. There are various levels for carrying out inspection and appraisal of buildings. If the main goal is general planning and strategy issues, the characterization in a general matter of the buildings in a specific zone constitutes an adequate level of inspection. But if a higher level of characterisation of buildings is pursued, then our objective is certainly more sophisticated, for example, an exhaustive and complete inspection and diagnosis, that could involve destructive and non-destructive testing, must precede an individualized rehabilitation project for a valued architectural building.

For example, to evaluate the structural vulnerability of old buildings, specific items must be surveyed, such as wall thickness, building height, plan configuration, type of soil and foundations, floor slab connections to masonry walls, masonry shear strength, etc. The influence of such effort on the level of inspection of buildings must be justified by the degree of action of future rehabilitations carried out. In truth the level of inspection must take direct effect on the quality and depth of rehabilitation and renewal actions, as well as maintenance. The presented methodology has as main aim to serve as tool for guiding urban planning and intervention, with particular importance from the building refurbishment and rehabilitation point of view for buildings in urban and historical centres, and also in the definition of maintenance policies and priorities. This methodology has contributed to the organization and decision aiding in a more supportive and clearer manner without compromising the nature of the intervention. Their exists no unique model, but general principles and major steps, so this methodology needs to be adapted and modified faced to different urban characteristics and features, as for final end-products. The survey carried out and presented is only upon the building physical inspection, other levels of inspection are not analyzed in this paper. The inspection and diagnosis check-lists are structured by building elements and components, previously defined and evaluated in a hierarchy manner. Each building element is surveyed by a check-list, recording and characterizing essentially materials, solution, condition state and defect analysis.

Conclusions

The importance and influence of the survey must not be underestimated. It is the natural point of interest at which all interested and involved parties will focus and discuss, identifying the needs of the building, understanding the buildings and finally put forward solutions, demands, decisions and practices. The results obtained give an accurate "image" of most of the old building stock in urban areas of our country and allow the analysis of the most relevant problems and defects and essential needs in terms of building refurbishment.

References

[1] aa.vv., 2000, *Proceedings of the 4th European Commission Conference Research for protection, conservation and enhancement of cultural heritage: opportunities for European enterprises*, Strasbourg, France, 22nd-24th of November, 2000.

[2] Urban II (2000), *Community Initiative of the European Regional Development Fund (ERDF) for sustainable development in the troubled urban districts of the European Union*.

[3] International Council on Monuments and Sites (2003) *ICOMOS Charter - Principles for the analysis, conservation and structural restoration of architectural heritage*, Ratified by the ICOMOS 14th General Assembly, in Victoria Falls, Zimbabwe, October 2003.

[4] Vicente R., Mendes da Silva J.A.R., Varum H. (2005) "Strategies for building pathology reports in an urban rehabilitation process. Project of the Old City Centre of Coimbra", *Proceedings of the 10thDBMC International Conference on Building Materials and Components*, Lyon, France, 17th-20th of April, 2005.

Evolution of building systems and building pathologies: "variables of interaction"

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The method and the capacity to construct evolved differently according to the nature of the place. Each "age" has had an approach to building since antique times, depending on the different materials and environmental needs and on the evolution of the technical "knowledge". This paper describes the "variables of interaction" between architecture-materials-techniques and the problems inherent in building recovery. Programming the building recovery for "the development of guidelines for the 21st century construction" must take into consideration the complex correlation between building technologies and related building pathologies. The aim is to requalify building and urban construction using technology that is open to innovation and contemporaneously to tradition.

Keywords: technology, recovery, pathology, restoration, consolidation.

1. Methodologies for intervention on buildings

Recovering our building heritage has a fundamental role regarding renewal process, since it constitutes one of the strategies for urban and territorial balance. Building recovery, in the broadest sense of the word, means the renewal of precious constructions which have decayed or outdated but could be renewed.

Therefore any intervention of building recovery needs a philological study as a starting point, which consists of a critical interpretation of the building and its context. Such a study is the result of an inseparable relation between the construction's "previous state" and its "current condition", or rather, between the materials and the constructive technique, the method from which form and function originated and the preset structural state which is obsolete.

The knowledge, or better the "recognition" as Cesare Brandi would say, is the instrument and, at the same time, the main cultural objective of recovery [1].

There are some fundamental principles which have to be respected in programming an intervention of building recovery: the "compatibility" of materials and of constructive techniques; the "identifiability" and the principle of "reversibility".

Reversibility gives the building the possibility to reinterpret or correct using possible solutions brought by technological innovations (new materials, techniques and constructing procedures). Reversible no invasive interventions (where possible), which focus on the quality and on the bearableness, are hoped. Other general criteria in the intervention on historical buildings are: durability, reliability, flexibility and maintainability.

Durability refers to the resistance of materials and the capacity of holding together the single components and the whole building.

Reliability varies different factors and concomitant causes which occur during the life of the building . As to flexibility, we have to take into consideration the relation between materials and constructive systems in view of a better functioning.

In the end maintainability refers to the planning, constructing and managerial stage.

In a planning stage the conditions (structural solution, details, materials and systems) can be programmed and determined for a good and correct maintainability.

These are the parameters of "technological congruence" which must be respected when involved in a recovery intervention, supported by a historical critical and technical-scientific study.

"…The intervention on a historical building focuses on the "real monument", on its role in civilization, on its place in the progressive development of history; monuments are like story-books whose pages must not be disarranged" [2].

This study means to make its contribution to the knowledge and to the recovery of the architectural patrimony which is chronological inserted in the arc of 20th century, to study its cultural and material weaving, spotlighting the truth of Palermo. It is characterized by an evident heritage and hidden inheritances which seem to be dim from successive human vicissitudes. The primary task of the research is to measure the congruence between the semantic and the material value of the good, to estimate its degradation risks, to decrease its vulnerability degree, that is "redeem it", protect it and give it back to the history that has conceived it. [3]. Limiting both material (structural degradations/physical obsolescence – requirements of safety/security) and cultural and environmental (function degradations-disregarded environmental requirements) risks and realizing the just conditions of fitness for human habitation, means to create new perspectives or "to continue to make history in the knowledge" according to B. Zevi's opinion [4].

2. The recovery of "Stand Florio" in Palermo: program and aims

Many places and spaces have been forgotten by history, usurped from their original meaning and suffocated from a sometimes little careful culture. We are going to present an example.
The "Stand Florio" (E. Basile – 1905) in Palermo shows some architectural peculiarities that should be understood, deepened and set off [5].
Its geographic position is very interesting: it looks to the sea, thanks to its town planning position on the coast (Messina Marine street).
It can be certainly considered in the "Liberty" typological category a meaningful architectural example that should be protected as heritage for the future of our generations.
The culture expressed in it should be set off because it is a mark of our nearer past. We can say that this expression of architecture is moreover the last one having an own well represented cultural identity and therefore it is important that it forms part of the memory of the future with the right recognitions. Recovering the meaning of these modern architectural expressions, means to add to the history those not ancient but pregnant and equally interesting sceneries of architecture for the next generations.
The stages of building recovery of Stand Florio – (Liberty building) start from an analysis of the decay of the masonry and of the exterior rendering. An accurate philological analysis of the building is effected starting from the historical and material data. The seriousness of the decay and of the upheavals is clear through a visual analysis. A mapping of the upheavals has been effected. The redevelopment and recovery project foresaw the reconfiguration of the façade.

3. Results

This study explore three main paths:
- historical definitions and building techniques;
- structural work on degraded concrete buildings;
- experiment new building and reclaim techniques and materials.

I – Acquisition of data-historical and technological analysis-cartography-visual analysis;

II – Diagnostics-degradation pathologies and physical-mechanical characteristics of structures-study of building procedures -data acquisition techniques for structural parts- plans for structural reclaims (durability and reliability);

III – Suggestions for interventions-structural reclaim methods through new materials -definitive interventions and non-destructive methods-building procedures for structural reclaim-building procedures for the prevention of degradation.

In conclusion the aim is to requalify building and urban construction using technology that is open to innovation and contemporaneously to tradition. The building recovery, being linked to urban recovery, constitutes the first element of identification of the image, of the city and of the territory. Any historical or modern, particular or common intervention of recovery should guarantee the continuity of the image or to give back integrity, damaged by alterations. In recovering buildings, the approach must be scientific. It means to redevelop and to compensate the breaks between past and present and to start new connections, respecting what already existed, and what is required today [6].

References

[1] Brandi C., (1997), *Teoria e pratica*, a cura di Cordaro M., Liguori, Napoli.

[2] Bellini A. (cur.), (1994), *Tecniche della conservazione*, Franco Angeli, Milano.

[3] Boscarino S., (1999), "Storia e storiografia contemporanea del restauro", in *Id, Sul restauro architettonico*, Franco Angeli, Milano, pp.121-131.

[4] Zevi B., *Architettura e storiografia. Le matrici antiche del linguaggio moderno*, Einaudi Editore.

[5] Caronia Roberti S., (1935), *Ernesto Basile e cinquantanni di architettura in Sicilia*, Palermo.

[6] Vitrano R.M., (2006), Costruibilità del nuovo e Tutela dell'Esistente – Analisi Prevenzione Recupero, Luciano Editore, Napoli.

"Technological parameters" of sustainability: factors of decay and prevention measures

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This is the age of the "global knowledge", of the "local inadequacies", of the specialistic enterprises and of the management difficulties. Today is necessary to create new perspectives to limit the risk both material (structural decay / physical obsolescence / security needs / static disease) and cultural and environmental (function degradations – inattentive environmental conditions) and to realize the right living conditions and protection for the development of guidelines for the 21st century construction. This research aims (in correlation between historical study and architectural analysis) at the creation of new instruments for developing a history of building technologies as they relate to their pathologies.

Keywords: pathology - sustainability - prevention - technology - recovery

1. Introduction

The boom of the building industry of the 50's and 60's, in the middle of the technological evolution, produced the modern "degraded" city, the outskirts without quality, the loss of the local urban characteristics, and moreover the destruction of the equilibrium with the environment.
How can we explain this involution? It wasn't the culture of the 20th century that started all this, as some may think, but the part of it that the common sub-culture has wanted and been able to receive, the craving for the maximum economic gain did the rest using a new material and technique (use of concrete) to further its needs, depriving the buildings of the most elementary requirements of security, durability, and trustworthiness. Apart from some "author architecture" examples, that are now in danger of not being valorised and understood, for a phenomenon of reaction and disenchantment, the results of the building industry are unsatisfactory, as anyone can see [1].

2. Sustainability and recovery strategies

Since the 70's we have acknowledged that the resources have to be protected with new strategies of urban and building recovery. "Recover sustainably" means assuring that the procedures are compatible with the necessity to better and protect the quality of life and of the environmental context for the future and present needs [2].
The direction of the evolutionary processes in the technological field, the creativity and ideals must seek the construction and guarantee a better future.
What's important, is to point out that the complexity of the building process and its gradual specialization, often remove the architect form the building, depriving him of his role as coordinator of the process.
Recover the architecture for a sustainable future means expanding the themes of recovery with consciousness and critical spirit.
Sustainable recovery means, as well, satisfying the modernization and innovation needs of the users, without damage to the quality of the environment.
This logic directs the design process from the performance of the single technological component (the quality of the single component can be indifferent in the best result of the whole) to the optimization of the whole architectonic organism in relation to the needs of the environment.
The programming of new "methodological instruments" finalized to the sustainability is based not only on the traditional control of the performance, but on an idea of global quality of the operations: (energy consumption containment, control of the aging of components with prevention as well etc) [3]. The correspondence between the needs (the security conditions, environmental well-being, durability, etc) and the requirements (the possible answers to the said conditions, in relation to the constructive system) of the organism and the norms that protect the user, it's a necessary condition to complete a recovery project achieving the objectives, the quality of the whole architectonic organism [4].

3. Quality and aging control

The quality of the building recovery is the result of the organization of the physical-space and functional variables related to the environmental components. The primary parmeters of the research of sustainability:

- reduction of the energy consumption (passive microclimatic control, use of renewable energy sources like solar energy etc);

- use of recycled and recyclable materials; - improvement of the acoustic aspects (external and internal walls, etc);
- improvement of the thermo-igrometric (with low impact methods that favour natural ventilation, natural summer cooling -wind towers, natural winter heating – solar greenhouses, to reduce the management costs);
- durability of materials and components (document the quality and characteristics of the products, for example the certifications of concrete) of particular importance for the concrete constructions that must guarantee static performance and resistance to environmental aggressions-maintenance and exchangeability of the components based on the life-span forecast of the single components (the technological systems have to be set in opportune spaces to be easily reachable).

These general directives are fundamental for a management of the quality of the building as a whole. This in fact can't be delegated exclusively to the structural materials, but to the total of the parts that make it and in different ways contribute to the final result.
The sustainability is a cultural availability that requires continuous exchanges amongst the different phases of the design, from the initial decisions to the mediated configurations.
The last thing to point out that at the base of any good design is the programming of a correct and punctual control of the project and the building site; form diagnostic data it is clear that many constructive errors and precocious aging are caused by the superficiality and management inadequatness.

4. Results

The stages of building recovery start from an "philological analysis" of the building (historical and material data). The objective is to restore the original meaning of the building correlating it to the needs of the present, or to establish a new balance in terms of "retraining" and "renewal".
Methodological proposals for sustainability interventions:

- interventions and non-destructive methods;
- building procedures for structural reclaim;
- plans for structural reclaims (durability and reliability);
- building procedures for the prevention of degradation (maintenance).

Results:

- documentation and information technologies for site interpretation and promotion (innovative instrument for data analyses);
- evaluating the role of heritage conservation in sustainable development;
- check on the validity of the new techniques on a sample building.

In conclusion any intervention of building recovery should guarantee the continuity of the image or to give back integrity, damaged by alterations. The designer's conscience and maturity is fundamental in interpreting rules, establishing methods and guiding the sustainability project [5].

References

[1] Manzini E., Artefatti. Verso una nuova ecologia dell'ambiente artificiale, Domus Acadeemy, Milano, 1990.

[2] Cangemi V., *Emergenza ambiente: teorie e sperimentazioni della Progettazione Ambientale*, 2001.

[3] Costrumat, 2004, *Construcciòn sostenibile*, Barcellona.

[4] AA.VV , 19 e 20 maggio 1995, Atti del Convegno Internazionale: *Qualità Control in Research laboratori. Il controllo di Qualità nei laboratori di ricerca sperimentale: costruzione e qualità ambientale*, Napoli.

[5] Daniels K., 1997, *The Technology of Ecological Building: basic principles and measures, examples and ideas*, Birkhauser Verlag, Basel.

Index of Authors

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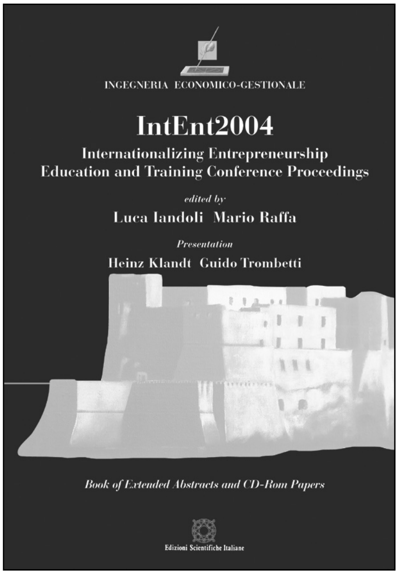
37. Luca Iandoli, Mario Raffa (ed. by), *Entrepreneurship Competitiveness and Local Development,* 2005
38. Roberto Formato, *Ingegneria del Turismo*, 2006
39. Roberto Pietroforte, Enrico De Angelis, Francesco Polverino (ed. by), *Construction in the XXI Century: Local and global challenges*, 2006



30

Luca Iandoli Mario Raffa (ed. by)

IntEnt2004

Internationalizing Entrepreneurship Education and Training Conference Proceedings

Presentation

Heinz Klandt Guido Trombetti

ISBN 88-495-0922-7
pp. 320; 2004; Euro 16,00 (libro+CD)

This book contains the extended abstracts of the about 70 papers presented at the IntEnt (Internationalizing Entrepreneurship Education and Training) Conference held in Napoli, on July 4-7, 2004. The book includes a CD-Rom collecting the full text of each paper.

IntEnt2004 provides a set of methods and research evidence in the field of Entrepreneurship. More specifically it focuses on education and training related topics. The purpose of this book is to stimulate further researches and provide an array of suggestions for academicians, professionals and practitioners.

31

Giuseppe Zollo (a cura di)

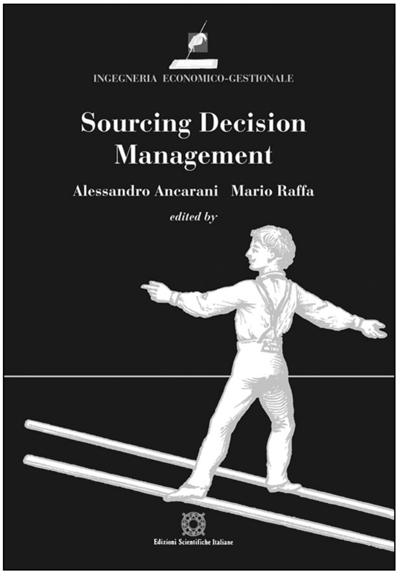
Valori, risorse e compentenze nelle organizzazioni

Presentazione
Vincenzo Naso Mario Raffa
Guido Trombetti

ISBN 88-495-0963-4
pp. 288; 2004; Euro 15,00 (libro+CD)

Questo volume contiene gli abstract estesi dei lavori presentati alla XV Riunione Scientifica Annuale dell'Associazione italiana di Ingegneria Gestionale (AiIG) ospitata a Napoli il 14-15 ottobre 2004.
Il volume include un CD-Rom contenente i lavori completi.

Valori, risorse e competenze nelle organizzazioni presenta un quadro d'insieme di alcuni dei filoni di ricerca che vengono sviluppati nell'area dell'Ingegneria gestionale dalle diverse sedi italiane. Il tema scelto è particolarmente rilevante in una fase di forte trasformazione dell'economia e delle imprese. La globalizzazione dei mercati, la formazione di estese reti di imprese e la digitalizzazione dei processi di trasformazione stanno spingendo tutti gli attori economici ad una profonda revisione dei valori, delle risorse e delle competenze, fattori su cui hanno basato tradizionalmente la propria capacità competitiva.
Il volume intende essere uno stimolo per future ricerche e suggerimenti per accademici, professionisti e ricercatori.



32

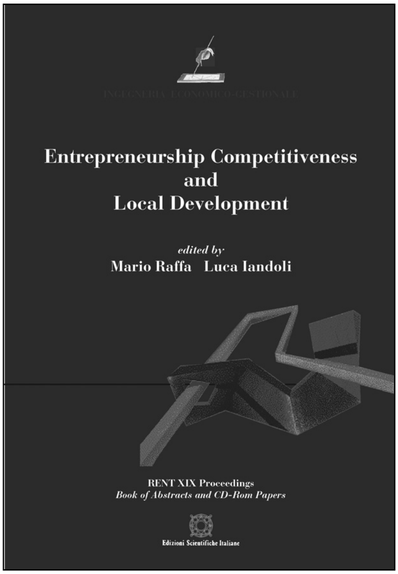
Alessandro Ancarani
Mario Raffa (a cura di)

Sourcing Decision Management

ISBN 88-495-1033-0
pp. 320; 2005; Euro 15,00

Managers are becoming increasingly aware of the amount of money involved in purchasing decisions related to production materials, investment goods, and services. Literature and practical observations highlight the need for a better understanding of the complexity of the source decision-making process, to support managers in these decisions. The increasing availability of modern information technologies makes it possible to use electronic means to exchange goods and services - definitively affecting sourcing decisions. However, a number of questions still require a clear answer: which applications are available and already effective; what are the effects of public procurement policy on the small and medium enterprises?

Sourcing Decision Management provides insights in the latest theoretical, methodological, and practical questions analysed by the academics working on these topics. Interrelated and complex dimensions of the sourcing decisions faced by companies are outlined. The book is intended to be useful from both the theoretical and practical point of view.



37

Luca Iandoli Mario Raffa (ed. by)

Entrepreneurship Competitiveness and Local Development

RENT XIX Proceedings

ISBN 88-495-1183-3
pp. 304; 2005; Euro 17,00 (libro+CD)

Entrepreneurship, Competitiveness and Local Development contains the abstracts of the 128 papers presented at the RENT XIX Conference held in Napoli on November 17-18, 2005.
The book includes a CD-Rom collecting the full text of each papers.

The field of entrepreneurship and small business studies has prospered and grown considerably during the past few years in all European countries. Remarkable development has taken place both in the research frameworks and methodologies. The scientific debate continues with entrepreneurship theory and discipline.

The 2005 RENT (Research in ENTrepreneurship and Small Business) Conference aims at stimulating such a debate on progress in the field of entrepreneurship and to promote dialogue on theory and practice in entrepreneurship and small business between the community of researchers and consultants serving policy bodies in the European Community and the European nations.

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