

# ICQSS 2011

## 14th QMOD conference on Quality and Service Sciences

From Learn*Ability* and Innov*Ability* to Sustain*Ability*

29-31 August 2011, San Sebastian, Spain

# Book of full papers



Universidad  
de Navarra



tecnun  
formando personas

**Proceedings**  
**QMOD Conference on Quality**  
**and Service Sciences 2011**

14th QMOD Conference  
29<sup>st</sup> – 31<sup>st</sup> August, 2011  
San Sebastian, Spain

*From LearnAbility & InnovAbility to  
SustainAbility*

**Title:**

Proceedings QMOD Conference on Quality and Service Sciences 2011

**Editors:**

Carmen Jaca,

Ricardo Mateo,

Elizabeth Viles

Javier Santos

**Published by:**

Servicios de Publicaciones Universidad de Navarra

Carretera del Sadar s/n

31080 Pamplona

Spain

**ISBN: 84-8081-211-7**

## Welcome message

It is an honour for us to welcome you to the 14<sup>th</sup> QMOD/ICQSS conference. The aim of the Conference is to focus on the three key themes of **LearnAbility, InnovAbility and SustainAbility**, all of which are necessary in today's business environments, which are constantly evolving towards higher complexity. All three key concepts indicate the importance of meta competencies in terms of our capability to learn (learnability), capability to innovate (innovability) and capability to sustain (sustainability). It is our belief that these meta competencies will become increasingly important in the coming years. Among the many issues which challenge modern management theories and practices are: The hyper competition, the increasing importance of intangible assets, cultural and ethnic diversity, the focus on quality of life, gender, organisational ecology, environmental sustainability, corporate social responsibility and risk management.

The QMOD conference has become one of the largest scientific conferences within the research fields of Quality, Service, Organisational Development and related research areas. The yearly QMOD conference is also proven to be a major forum where academics as well as practitioners from all around the world have the opportunity to exchange their knowledge and experiences and thereby built a '**QMOD Community**'. Through this forum, we can discuss and share our research and experiences in order to be able to draw a more accurate picture of organisational and business realities, and thereby to improve our diagnosing capabilities of current problems and improvement opportunities.

We take this opportunity through this written welcome to express our recognition of the effort and work put in by all those people who have made it possible to organise **QMOD 2011**: we pay tribute to the Scientific Committee who have assured the quality of the accepted papers, to the members of the organising committee for their keen motivation and to all the people who have directly or indirectly influenced the smooth progress towards the conference.

Finally, we would like to express much gratitude to all of the authors for contributing their papers. We hope you will find the conference schedule we have prepared interesting and worthwhile, and we encourage you to enjoy the delights offered to us by San Sebastian, our host city.

Donostia – San Sebastián, August 2011

QMOD Organising Committee

## INDEX

---

I HAVE NO IDEA WHAT I'M DOING. CUSTOMERS AS INCOMPETENT SERVICE WORKERS .....	1
Annika Åberg, Markus Fellesson	
THE RISING POWER OF LEAN SIX SIGMA WITHIN THE GULF COOPERATION COUNCIL COUNTRIES: A CASE STUDY IN THE SERVICE SECTOR.....	14
Shadi Abouzeid, Susan Zeidan	
UNIVERSITY SERVICES FOR REGIONAL DEVELOPMENT - IDEAS ON STAKEHOLDER BASED QUALITY MANAGEMENT IN A REGION.....	36
Sten Abrahamsson, Maria Fredriksson, Raine Isaksson	
FUTURE ROLE OF STANDARDIZATION IN PULP & PAPER'S SECTOR .....	74
Manel Alcalà, Martí Casadesús, Frederic Marimón	
ADVANCE MATHEMATICAL MODEL TO STUDY AND ANALYSIS THE EFFECT OF TOTAL QUALITY MANAGEMENT (TQM) AND OPERATIONAL FLEXIBILITY ON HOSPITAL PERFORMANCE.....	86
Main Naser Alolayyan, Khairul Anuar Mohd Ali , Fazli Idris, Ahmmed Saadi Ibrehem.	
LESSONS LEARNED FROM QUALITY MANAGEMENT SYSTEMS DIFFUSION IN HOSPITALITY SECTOR IN SPAIN .....	94
María Del Mar Alonso-Almeida, Merce Bernardo, Frederic Marimon, Josep Llach	
ADAPTING A SURVEY TO EVALUATE QUALITY IMPROVEMENTS FOLLOWING THE BREAKTHROUGH METHODOLOGY IN SWEDISH HEALTHCARE .....	102
Ann-Christine Andersson, Mattias Elg, Kent-Inge Perseius, Ewa Idvall	
THE POST CRISIS SUSTAINABLE MANAGEMENT VISION FOR EXCELLENCE:IMPLICATIONS FOR BUSINESS EDUCATION .....	117
Loukas N. Anninos, Leonidas S. Chytiris,	
BUDGET RATCHETING AND THE PRODUCTION FUNCTION .....	131
Carmen Aranda, Javier Arellano, Antonio Davila	
THE AUGMENTED REALITY IN THE CULTURAL HERITAGE SECTOR .....	158
Gabriella Arcese, Laura Di Pietro, Roberta Guglielmetti	
MANAGING BY APPRECIATIVE LEADERSHIP TO CREATE EFFICIENT ORGANIZATIONS AND HEALTHY CO-WORKERS .....	171
Anna Åslund, Ingela Bäckström, Daniel Richardsson,	
COMBINING MECHANISTIC AND ORGANIC APPROACHES TO CHANGE: A CASE STUDY ON A SWEDISH NATIONAL TRANSFORMATION PROGRAM FOR MEDIUM SIZED ENTERPRISES .....	179
Marcus Assarlind, Clas Mellby	
A HEALTH-RELATED QUALITY MANAGEMENT APPROACH TO EVALUATING HEALTH PROMOTION ACTIVITIES. ....	188
Ingela Bäckström, Lina Eriksson, Yvonne Lagrosen,	
CUSTOMER EXPERIENCE CREATION: THE CASE OF TRANSPORT SERVICES COMPANY TRANSTEDA LTD	198
Liudmila Bagdoniene, Jurgita Zembylte	
A HOLISTIC APPROACH TO DECISION THEORY-BASED INSPECTION PLANNING.....	214
I. Basse, R. Schmitt.	

IDENTIFYING AND EVALUATING CHARACTERISTICS THAT ARE DIFFICULT TO QUANTIFY USING THE REPERTORY GRID TECHNIQUE .....	225
Katrin Baumert, Daniel Baier, Michael Brusch	
STUDENT SUGGESTIONS FOR QUALITY DEVELOPMENT OF UNIVERSITY OPERATIONS .....	232
Martina Berglund, Johan Karlton	
FACTORS OF INFLUENCE IN THE LOYALTY OF CLIENTS IN KNOWLEDGE INTENSIVE BUSINESS SERVICES (KIBS): A TRANSACTION COST AND RELATIONAL MARKETING APPROACH.....	242
Luis E. Bernal Vera, Utz Dornberger	
A QUALITATIVE STUDY ON MANAGEMENT SYSTEMS INTEGRATION .....	251
Merce Bernardo, Katerina Gotzamani, Fotis Vouzas, Marti Casadesus	
RECOVERING FROM THE CRISIS: IS AN EXCELLENCE APPROACH A REFERENCE POINT FOR LEARNABILITY, INNOVABILITY AND SUSTAINABILITY? .....	264
Louise Boulter, Jens Dahlgaard	
EVALUATION OF SUCCESS FACTORS FOR INNOVATION- AND COMPETITIVE STRATEGY .....	272
Jennifer Bredtmann,	
OPERATIONALIZATION OF MARKET ORIENTATION CONCEPT IN HIGHER EDUCATION INSTITUTIONS....	286
Bugandwa Mungu Akonkwa Deogratias,	
ENDOGENOUS AND EXOGENOUS DRIVERS OF CUSTOMER SATISFACTION: A CASE STUDY ON SHOPPING CENTRES SERVICES .....	308
Clara Cicatiello, Silvio Franco, Barbara Pancino	
CREATING BENCHMARKS FOR HIGH PERFORMING .....	322
Graeme Cocks,	
GOING SHOPPING FOR INDEPENDENT DIRECTORS: THE MAKE-UP OF THE IDEAL EXTERNAL BOARD MEMBER.....	332
Graeme Cocks, Jens Mueller, Morina Rennie, Coral Ingley	
QUALITY MANAGEMENT IN HOTELS IN THE BASQUE COUNTRY .....	342
Anna Colomer, C. Jaca, E. Viles, M. J. Alvarez	
OPTIMIZING THE DEVELOPMENT PROCESS BY AN OPTIMAL METHOD-SELECTION USING INDIVIDUAL CHARACTERISTICS – AN APPROACH .....	351
Alexander Crostack, Arun Nagarajah, Robert Refflinghaus	
IMPROVING THE HEALTH CARE SERVICE QUALITY BY USING THE HEALTH EXAMINATION DATA TO PREDICT THE RISK OF COLON CANCER .....	370
Chun-Yuan Cheng, Fang-Chih Tien, Ko-Han Sun, Mei-Ling Liu	
THE RELATIONSHIP BETWEEN WORKING SATISFACTION AND SERVICE QUALITY OF THE ELDERLY CARE ATTENDANTS AND MODERATING EFFECT OF ETHICAL CLIMATE.....	379
Chihyang Chao, Peiyu Ku, Yenhui Lin	
THE KEY FACTORS AND RELATIONSHIP BETWEEN TQM AND SERVICE QUALITY OF ACCOUNTANTS IN TAIWAN HIGH SCHOOL.....	394
Chihyang Chao, Yenhui Lin, Peiyu Ku	
FACT: A COMPREHENSIVE BUSINESS EXCELLENCE MODEL.....	413
Chi-Kuang Chen, Jiun-Yi Jang,	

COMBINING TECHNICAL AND SOCIAL ASPECTS TO CONDUCT A SUCCESSFUL BPR PROJECT .....	438
Chi-Kuang Chen, Nicolle Suazo, Cheng-Ho Tsai	
RM PRACTICES-ORGANISATIONAL PERFORMANCE RELATIONSHIP FRAMEWORK REFINED: A CIRCULAR MODEL REPRESENTATION .....	465
Alexandra-Paraskevi L. Chytiri,	
ORGANIZATIONAL INNOVATION CAPABILITY, PRODUCT PLATFORM DEVELOPMENT AND PERFORMANCE. THE CASE OF IRANIAN API COMPANIES, TAPIC SUBSIDIARIES .....	481
Hossein Dadfar, Amir Alamirhoor, Staffan Brege, Jens J. Dahlgaard	
FACTORS AFFECTING THE SUSTAINABILITY OF QUALITY MANAGEMENT PRACTICES: AN AGENDA FOR FUTURE RESEARCH .....	504
Mehran Doulatabadi	
INTRODUCTION OF DEBATE AS A TEACHING METHOD IN UNIVERSITY CURRICULUMS .....	519
Mirjana Drakulić, Nevenka Žarkić Joksimović, Svetlana Jovanović, Goran Jankuloski.	
VISUAL PLANNING APPLIED IN A RESEARCH ENVIRONMENT .....	530
Evelina Ericsson, Joakim Lilliesköld, Liv Marcks Von Würtemberg.	
THE EFQM EXCELLENCE MODEL AND INNOVATION; THE KEY ROLE OF HUMAN RESOURCES PRACTICES (HRP).....	542
Naiara Escribá-Carda, Maria Teresa Canet-Giner, Francisco Balbastre-Benavent, Virginia Simón Moya, Lorenzo Revuelto-Taboada	
A NEW MODEL FOR PREDICTING INTERNATIONAL STUDENTS SATISFACTION: MALAYSIAN UNIVERSITIES CASE.....	559
Ahmadreza Shekarchizadeh Esfahani, Amran Rasli, Asm Shahabuddin	
MANAGEMENT SYSTEMS AND ORGANIZATIONAL IMPROVEMENT .....	575
Sharareh Mirsaeidi Farahan, Gholamreza Chitsaz.	
QUALITY CONTROL AND CAPABILITY IMPROVEMENT FOR ADVANCE CDSEM MEASUREMENT .....	589
Kelly Feng, P.Y Lee, Thomas Tseng, H.F. Huang, Jacky Wei A	
HEALTH CARE IMPROVEMENT AND LEARNING– A STUDY OF EMERGING ISLANDS AND SYSTEM-WIDE APPROACHES .....	602
Rickard Garvare, Monica E. Nyström, Elisabet Höög, Anna Westerlund	
NEW METHODS IN UNIVERSITY ENTREPRENEURSHIP EDUCATION: AN APPROACH TO MULTIDISCIPLINARY TEAMS .....	620
Esperanza Gil-Soto., Francisco J. García-Rodríguez, C. Inés Ruiz-De-La-Rosa	
THE STUDY OF THE RELATION BETWEEN TOTAL QUALITY MANAGEMENT AND SERVICE QUALITY IMPROVEMENT LEADING TO AN OPTIMAL MODEL PRESENTATION .....	637
Mohammadbagher Gorji. Sahar Siami	
COPING WITH SERVICE DEVELOPMENT IN A FORCED RELATIONSHIP CONTEXT .....	653
Patrik Gottfridsson, Carolina Camén, Markus Fellesson	
CUSTOMER SATISFACTION TO IMPLEMENT BENCHMARKING IN THE PUBLIC SECTOR .....	669
Roberta Guglielmetti,	
IDENTIFICATION OF CUSTOMER NEEDS IN HEALTHCARE –TRANSLATING PATIENT NEEDS INTO CRITICAL-TO-QUALITY CHARACTERISTICS.....	689
Susanne Gustavsson	

HOW TO IMPROVE QUALITY COST ACCOUNT? .....	707
Adam Hamrol, Marta Grabowska	
DECODE+X IN KITVES. USING THE DEMAND COMPLIANT DESIGN IN THE DEVELOPMENT OF A SOLUTION FOR HARVESTING HIGH-ALTITUDE WINDS FOR ENERGY GENERATION ON VESSELS.....	721
Christine Hartmann, Petra Winzer	
ON OF QUALITY BASED PERFORMANCE MEASUREMENTS AND PRACTICES IN SERVICE SECTOR SMES..	738
Shirley Ann Hazlett, Rodney Mcadam	
THE INFLUENCE OF THE TIDY WORK ENVIRONMENT IN THE RELIABILITY OF THE CONSCIENTIOUS INDIVIDUALS.....	772
Jose Hernandez, Ricardo Mateo, Szabolcs Blazsek,,Carmen Jaca	
INNOVATION THROUGH THE COMMON ASSESSMENT FRAMEWORK- IN A PUBLIC ADMINISTRATION .	792
Thierry Hirtz, Claire Navarra	
SERIOUS GAMES AS AN APPROACH TO CREATE INNOVATION AND SUSTAINABILITY TAKING GENDER ASPECTS INTO CONSIDERATION .....	814
Gabriele Hoeborn, Jannicke Baalsrud, Jennifer Bredtmann*, Petra Heinich	
PERFORMANCE-BASED LOGISTICS. A LITERATURE REVIEW .....	827
Martin Holmbo	
EVALUATING E-SERVICE QUALITY BASED ON INTERDEPENDENCE PERSPECTIVE .....	849
Tsuen-Ho Hsu, Li-Chu Hung, Jia-Wei Tang	
IMPLEMENTATION OF TQM APPROACH IN THE UNIVERSITY ENVIRONMENT.....	871
Milan Hutyra,	
THE IMPORTANCE OF QUALITY IMPROVEMENT ACTIVITIES BASED ON LONG-TERM RELATIONSHIPS WITH CUSTOMERS: RESEARCH ON THE CONTINUOUS GROWTH OF COMPANIES IN THE LAND TRANSPORT SERVICE INDUSTRY .....	880
Fumihiko Isada	
CHANGE MANAGEMENT FROM A STAKEHOLDER PERSPECTIVE.....	886
Raine Isaksson, Jacob Hallencreutz-Tech. Dawn-Marie Turner, Rickard Garvare	
SUSTAINABLE DEVELOPMENT IN UNIVERSITIES – THE POWER AND ROLE OF VISIONS AND GOALS.....	902
Raine Isaksson, Mikael Johnson	
VALUE STREAM MAPPING AS A TOOL TO IMPROVE THE SERVICE DELIVERY PROCESSES – A CASE STUDY .....	915
T. BARTOSZ KALINOWSKI.	
THE USE OF EFQM MODEL IN PERFORMANCE ASSESSMENT OF SUGGESTIONS SYSTEM .....	925
Seyed Mohammad Hossein Kamani, Somaye Sadat Morshedi	
IDENTIFICATION AND ANCHORING OF CUSTOMER REQUIREMENTS BASED ON A CUSTOMER QUESTIONNAIRE AND AN IN-HOUSE SURVEY .....	941
Anna Karlsson, Ove Isaksson	
CO-OPETITION STRATEGY IN BUSINESS EXCELLENCE: CONFRONTING THE ECONOMIC CRISIS .....	949
Ioannis Katsanakis, Dorothea Kossyva, Evanthia Vorria	

CROSS-DISCIPLINARY METHOD FOR PREDICTING AND REDUCING HUMAN ERROR PROBABILITIES IN MANUAL ASSEMBLY OPERATIONS .....	959
Christian Kern, Robert Refflinghaus	
IDEA OF QUALITY VERSUS IDEA OF EXCELLENCE.....	973
Marko Kiauta,	
QUALITY REQUIREMENTS FOR PRODUCTION SOFTWARE .....	982
Claudiu Kifor, Nicolae Tudor	
MEASURING EFFICIENCY OF LOGISTICS PROCESSES IN DISTRIBUTION CENTERS.....	996
Milorad Kilibarda, Milan Andrejić, Milorad Vidović,	
THE IMPORTANCE OF GRAPHICAL TOOLS FOR MEASUREMENT SYSTEMS ANALYSIS .....	1010
Pavel Klaput, Jiří Plura,	
PRACTICAL APPLICATION OF FUZZY LOGIC IN PROCESS CONTROL .....	1029
Martina Kohoutová, Milan Hutyra,	
AN EXTENDED FUZZY QFD METHODOLOGY IN THE DESIGN AND EVALUATION OF ACADEMIC COURSES .....	1039
Kamvysi Konstantina, Gotzamani Katerina, Andronikidis Andreas, Georgiou C. Andreas,	
CO-OPETITION STRATEGY IN BUSINESS EXCELLENCE: CONFRONTING THE ECONOMIC CRISIS .....	1063
Ioannis Katsanakis, Dorothea Kossyva, Evanthia Vorria	
KNOWLEDGE MANAGEMENT IN PAKISTANI SMES.....	1073
Nadeem Kureshi. Pnec,	
INNOVATION QUALITY .....	1080
Katja Landgraf, Roland Jochem	
PUTTING APPRECIATIVE DESIGN INTO PRACTICE: A CASE STUDY OF A COURSE EVALUATION AND DESIGN PROCESS .....	1089
Johan Lilja; Daniel Richardsson;	
UNIVERSITY SERVICES FOR REGIONAL DEVELOPMENT – THE CASE OF KNOWLEDGE MANAGEMENT OF CHANGE COMPETENCE IN GOTLAND .....	1102
Mia Ljungblom, Raine Isaksson, Jacob Hallencreutz	
RETHINKING THE RISK MATRIX.....	1116
Alberto Lombardo, Stefano Barone	
IMPROVEMENT SYSTEMS IN ENGINEERING .....	1126
Knut Lynum,	
EXAMINATION OF THE MEDIATING AND MODERATING EFFECTS OF EMPLOYEE FOCUS ON THE RELATIONSHIP BETWEEN SUSTAINABILITY PRACTICES AND ORGANIZATIONAL PERFORMANCE.....	1135
Matjaž Maletič, Damjan Maletič, Boštjan Gomišček,	
MALCOLM BALDRIGE NATIONAL QUALITY AWARD LEADERSHIP MODEL –AN ASSESSMENT OF TURKEY .....	1148
Esra Mankan	
RELATIONSHIP BETWEEN INTERNATIONALIZATION AND QUALITY OF UNIVERSITY RESEARCH .....	1156
Frederic Marimon, Xavier Triadó, Pilar Aparicio	

KEY DETERMINANTS OF LEAN PRODUCTION ADOPTION: EVIDENCE FROM THE AEROSPACE SECTOR .	1170
Pedro José Martínez-Jurado, José Moyano-Fuentes	
ISO 9001:2000 APPLICATION ACCORDING TO TQM IN SMES: AN EMPIRICAL RESEARCH .....	1185
Angel R. Martínez-Lorente, Micaela Martínez-Costa, Daniel Jiménez-Jiménez	
SHOPPING FREQUENCY AND MAXIMAL CUSTOMER SATISFACTION IN SPANISH FOOD RETAILING: IMPLICATIONS AND MANAGERIAL OPPORTUNITIES .....	1199
María Pilar Martínez-Ruiz, Alicia Izquierdo-Yusta, Ana Isabel Jiménez-Zarco	
THE RAPID RESULTS INITIATIVE: THE MISSING LOOP .....	1218
Simmy M. Marwa,	
ANALYZING THE GAP BETWEEN PRACTICE AND LITERATURE REGARDING THE USE OF QUALITY FUNCTION DEPLOYMENT (QFD) AND KANO MODEL IN A NEW PRODUCT DEVELOPMENT PROCESS ...	1230
Maryam Ghanadpour, Simon Schütte, Johan Ölvander, Nils Poirisse Mougel	
EFFECTS OF WELL ORGANIZED WORKING ENVIRONMENT IN HUMAN RELIABILITY .....	1251
Ricardo Mateo , Jose Hernandez, Szabolcs Blazsek, Elizabeth Viles	
IDENTIFICATION OF SEMANTIC SPACE OF HEDONOMIC AND THE MOST PREFERABLE ROAD LANDSCAPE .....	1266
Irina Matijošaitienė; Inga Stankevičė;	
A COMPREHENSIVE SURVEY ON ITALIAN SA8000 CERTIFIED FIRMS.....	1278
Merli Roberto, Ippolito Christian.	
UNIVERSITY STUDENTS' PERCEPTION OF SERVICE QUALITY OFFERED BY TRAVEL AGENCIES .....	1297
Halil Nadiri,	
KANSEI PRODUCT AND PRODUCT INNOVATION ON THE KYOTO LONG-STANDING COMPANIES .....	1312
Shin'ya Nagasawa, Yusuke Irisawa	
MEASUREMENT OF CUSTOMER SATISFACTION IN BUSINESS NETWORKS .....	1321
M.Sc. Jan-Peter Nicklas, Petra Winzer	
CHOICE OF PRIMARY CARE IN SWEDEN: AN EXPLORATIVE STUDY OF CITIZEN STATEMENTS BASED ON DISCOURSE ANALYSIS .....	1337
Lars Nordgren, Bengt Ahgren	
PROCESS IMPROVEMENT: A TQM APPROACH .....	1351
Uche Nwabueze	
ENVIRONMENTAL MANAGEMENT MODEL AND DEFINITION OF THE DIFFERENT MATURITY STATES. .	1359
Marta Ormazábal, Jose M <sup>a</sup> Sarriegi	
QUALITY IN HIGHER EDUCATION THROUGH STRATEGIC PLANNING .....	1370
M.S. Luis Efrén Veloz Ortiz., M.S. Iovanna Rodríguez Moreno, Fermín González García	
EXPERTS TEACHERS: QUALITY FACTOR IN HIGHER EDUCATION .....	1376
M. S. Jorge Veloz Ortiz, M. S. Iovanna Rodríguez Moreno, Fermín González García	
MEASUREMENT OF SERVICE QUALITY BY SERVQUAL METHOD IN BANKING SECTOR.....	1380
Nihan Ozguven, Erhan Demireli,	

HAFITE: A THEORETICAL MODEL AS A TOOL TO HELP PROMOTING THE INVOLVEMENT OF EMPLOYEES IN THE COMPANY.....	1389
Luis Paipa, Carmen Jaca, Javier Santos, Elisabeth Viles, Ricardo Mateo	
CUSTOMER SATISFACTION METRICS IN HEALTH SERVICE ORGANIZATIONS: EVIDENCE FROM THE GREEK HOSPITALITY SECTOR.....	1404
Angelos Pantouvakis, Athanassios Dimas	
LISTENING TO THE VOICE OF THE PATIENT: NEW INSIGHTS IN HEALTH CARE SERVICE DEVELOPMENT .....	1423
Bozena Poksinska , Lars Witell, Jon Engström, Mattias Elg,	
THE “FACTORY OF PROBLEMS”: IMPROVEMENT OF THE QUALITY IMPROVEMENT PROCESS .....	1439
Lourdes Pozueta, Jose Alberto Eguren, Unai Elorza Iñurrategi	
DETERMINING ISO 9001 EFFECTIVENESS AND THE INFLUENTIAL CRITICAL FACTORS IN MANUFACTURING COMPANIES .....	1453
Evangelos L. Psomas, Dimitrios P. Kafetzopoulos, Christos V. Fotopoulos	
THE INFLUENCE OF HUMAN RESOURCES MANAGEMENT ON PROJECT SUCCESS AND BUSINESS EXCELLENCE. THE POLISH CASE .....	1472
Rafał Haffer, Joanna Haffer	
EXPLORING THE PRACTICAL IMPLEMENTATION OF CORPORATE SOCIAL RESPONSIBILITY IN THE MINING INDUSTRY .....	1485
Helena Ranängen, Thomas Zobel	
OPTIMIZATION OF THE REQUIREMENT-ORIENTED PRODUCT DEVELOPMENT BY A FUNCTIONS DIFFERENTIATION WITHIN A HOLISTIC SYSTEM DESCRIPTION .....	1504
Florian Riekhof, Petra Winzer	
ASSESSMENT OF PUBLIC SERVANTS PERFORMANCE: LOOKING FOR THE POSSIBILITY .....	1514
Tatiana Salimova, Vasilij Makolov, Natalya Vatolkina, Nikolaj Zalogov	
A BENEFIT BASED SEGMENTATION AS A MANAGEMENT TOOL TO IMPROVE SERVICES’ QUALITY IN SHOPPING CENTRES .....	1529
Alessandro Ruggieri, Cecilia Silvestri, Barbara Pancino, Silvio Franco	
USING E-S-QUAL TO MEASURE INTERNET SERVICE QUALITY OF E-COMMERCE WEBSITES IN GREECE.	1544
Ilias Santouridis, Panagiotis Trivellas, Georgios Tsimonis	
SUSTAINABLE AND INNOVATIVE PUBLIC TRANSIT - BUS RAPID TRANSIT (BRT) SYSTEM THINKING IN SOCIAL CONTEXT .....	1558
Samuel Petros Sebhatu, Bo-Jacob Enquist	
INNOVATING VALUE-CONFIGURATION SPACES: INSIGHT FROM PUBLIC TRANSPORT SERVICES .....	1570
Samuel Petros Sebhatu, Heiko Gebauer, Bo Enquist, Mikael Johnson	
INTEGRATING MANAGEMENT SYSTEMS: A DYNAMIC STUDY OF SPANISH FIRMS .....	1578
Alexandra Simon, Stanislav Karapetrovic, Martí Casadesús	
ROBUST DESIGN METHODOLOGY AT THE BACK-END OR PRODUCT DEVELOPMENT PROCESS; AN ATTEMPT TOWARDS SUSTAINABLE DEVELOPMENT .....	1597
Vanajah Siva, Hendry Raharjo, Bolennarth Svensson, Ida Gremyr	

SUPPLY CHAIN QUALITY RELATIONSHIP MANAGEMENT: MANAGING TRIADIC RELATIONSHIPS TOWARDS IMPROVED PERFORMANCE OUTCOMES .....	1612
Anabela Da Silva Filipe Soares, Ebrahim Soltani	
EXCELLENCE TOOLBOX - DECISION SUPPORT SYSTEM FOR QUALITY TOOLS & TECHNIQUES SELECTION AND APPLICATION .....	1626
Beata Starzyńska, Adam Hamrol,	
EXPLORING ENVIRONMENTAL LABELING AS A MEANS OF PRODUCT DIFFERENTIATION IN THE OUTDOOR INDUSTRY .....	1645
Petter Stenmark, Johan Lilja	
REFLEXION OF VARIOUS PERSPECTIVES OF PREVENTION – WHAT QUALITY MANAGEMENT CAN LEARN FROM? .....	1653
C. Stiller, R. Woll	
APPLYING GEMBA-KAIZEN IN A MULTINATIONAL FOOD COMPANY—A PROCESS INNOVATION FRAMEWORK.....	1664
Manuel F. Suárez-Barraza, Juan Ramis-Pujol, Mariana Estrada-Robles, Luis E. Casado-Navarro	
TWO LEAN ROADS .....	1692
Dag Swartling	
BENEFITS OF THE ISO 9001 AND ISO 14001 STANDARDS: A LITERATURE REVIEW .....	1704
Juan José Tarí, José F. Molina-Azorín, Iñaki Heras	
PRODUCT FLOW VS. DATA FLOW. A DISCUSSION OF THE NEED FOR HARMONIZING THE MATERIAL AND DATA FLOW IN A MANUFACTURING ENVIRONMENT. ....	1718
Brandon Theiss,	
OPERATIONAL RISK MANAGEMENT FOR AN ELECTRIC UTILITY BASED ON BASEL ACCORD .....	1723
Dionicio Peña Torres, Carlos Rodríguez Monroy, Pablo Solana, Alejandro Solimando.	
SEPARATING THE MEASUREMENT AND EVALUATION OF INTELLECTUAL CAPITAL ELEMENTS .....	1740
Zsuzsanna E. Tóth, Tamás Jónás	
SERVICE QUALITY, JOB SATISFACTION AND ORGANIZATIONAL COMMITMENT IN HIGHER EDUCATION. AN EMPIRICAL STUDY OF FACULTY AND ADMINISTRATION STAFF.....	1755
Panagiotis Trivellas, Dimitra Dargenidou,	
REDUCING WASTE IN THE SUPPLY CHAIN LINKING SHANGHAI TO DETROIT: OBSERVATIONS AND RECOMMENDATIONS .....	1755
Behrooz Lahidji, Walter Tucker,	
QMS DEVELOPMENT TOWARDS STRATEGIC ADVANTAGES.....	1784
Wieslaw Urban	
CONDITIONS RELATED TO THE IMPROVEMENT OF QUALITY MANAGEMENT SYSTEMS IN ENTERPRISES OPERATING IN POLAND .....	1799
Maciej Urbaniak.	
MARKET ORIENTATION AND THE UNIVERSITY – A REVIEW AND RESEARCH AGENDA .....	1810
Johanna Julia	
RELIABILITY IN EARLY PRODUCT DEVELOPMENT PHASES. USING THE DECODE+X APPROACH FOR A DATA-BASED DISCUSSION OF DESIGN DECISIONS.....	1832
Maren Willing, Florian Riekhof, Petra Winzer	

INTEGRATION OF A LEVEL-MODEL FOR DIFFICULT TO QUANTIFY CHARACTERISTICS IN A REFERENCE PROCESS OF PRODUCT DEVELOPMENT .....	1848
R. Woll.	
LIMITS OF QUALITY MANAGEMENT .....	1861
R. Woll	
STRATEGIC IMPROVING ACTIONS BASED ON THE REFINED ANALYSIS OF SERVICE AND QUALITY ATTRIBUTES .....	1870
Ching-Chow Yang, Chung Yuan	
MEASURING THE ANTECEDENTS OF LOYALTY AND IMPACT OF ISO 9001 IN ONLINE BANKING IN SPAIN .....	1883
Luc Honore Petnji Yaya, Frederic Marimon, Marti Casadesus	
EMPOWERMENT OF THE LINE MANAGERS IN HRM—HRM EFFECTIVENESS LINK: CREATING A SERVICE CULTURE IN MALAYSIAN LARGE SERVICE FIRMS.....	1898
Yusliza Mohd.Yusoff.	
THE EVALUATION AND RANKING OF HOTEL SERVICE QUALITYFACTORS BY SERVQUAL AND FUZZY MCDM .....	1913
Vahab Vahdat Zad, Shahnaz Nayebzadeh, Mohammad Daei	
MANAGERIAL COACHING: A PRACTICE-THEORY BASED STUDY OF CONTROL AND SUPPORT.....	1931
Per Echeverri	
ISO 14001 CERTIFICATION IN SWEDISH FIRMS: A TOOL FOR THE NEEDY OR A SYMPTOM OF GREENNESS? .....	1949
Thomas Zobel	
VALUE-BASED PERFORMANCE EXCELLENCE MODEL FOR HIGHER EDUCATION INSTITUTION: A CONFIRMATORY FACTOR ANALYTIC (CFA) APPROACH SO 14001 CERTIFICATION IN SWEDISH FIRMS: A TOOL FOR THE NEEDY OR A SYMPTOM OF GREENNESS? .....	1962
Mohd Rashid Ab Hamid, Zainol Mustafa, Nur Riza Mohd. Suradi, Fazli Idris, Mokhtar Abdullah	

# Rethinking the risk matrix

**Alberto Lombardo. University of Palermo, Department of Chemical, Managerial, Information and Mechanical Engineering, Viale delle Scienze, 90128 Palermo, Italy  
alberto.lombardo@unipa.it**

**Stefano Barone. University of Palermo, Department of Chemical, Managerial, Information and Mechanical Engineering, Viale delle Scienze, 90128 Palermo, Italy.  
stefano.barone@unipa.it**

**Key words:** Risk matrix, Risk sustainability, Managerial perspective, Social perspective

## Introduction

Any decision under uncertain conditions imposes to evaluate the ‘risk’ related to the possible consequences. Such evaluation can be absolute or relative. However, in both cases a quantitative indicator is needed to take into account all factors involved in the ‘risk’. In the first case (absolute evaluation), it is necessary to express such indicator as a measure in monetary, material or human terms (cost, number of causalities, etc.). Also in the second case (relative evaluation), this assignment is necessary but it looks less critical, because a proportional error in the definition of the measure will be neutralized.

In both cases above, the definition of risk and its measure are often confused.

In an ideal world we would like that the negative consequences (*Loss*) be null or minimal. This should be the goal of the improvement work, in technology and human sciences. Any ‘measure’ that clouds this aim or deflects from this path, has inside something wrong.

Since the consequences are usually ‘possible’, the definition – or, better, the measure – of risk is inevitably associated with the concept of probability.

Unfortunately, as we will see in this note, even if the consequences are correctly evaluated and the probability is a well-established measure, an ‘inappropriate’ mix of the two can lead to a ‘risky’ evaluation of risk. This idea will be described in Section 2 and Section 3 and further clarified by an illustrative example in Section 4.

## The Risk Matrix

Pioneer work on establishing a common definition of Risk was started in the early 60’ with Wood (1964), where risk is defined as an objective state differing from the concept of uncertainty, more related to a subjective state. Many papers have studied the relation between the perception of probability in comparison with the rational computation. This link between risk and perception of risk has been object of further studies, see e.g. Weber and Milliman (1987). They also discuss the influence of posing a question concerning a consequence either in positive (gain) or in negative (loss) way.

As for the measure of risk, a milestone work was due to Kaplan and Garrick (1981) where, in place of a simple univariate measure of risk, a more complex definition including scenarios and risk curves was proposed.

However, despite more complex definitions, in the practice of risk management, the tool generally adopted to classify risk levels is the so called *Risk Matrix*. The risk matrix has two dimensions, likelihood and severity, both usually classified on five levels. The risk level, reported on each cell of the matrix, can be usually classified on three-five levels. The risk matrix reported in Table 17 is just an example. Slight modifications can be found depending on the specific risk analysis context.

**Table 17. Risk matrix**

LIKELIHOOD	CONSEQUENCES				
	Insignificant	Significant	Moderate	Severe	Extremely severe
Almost certain	High	High	High	Very high	Very high
Likely	Medium	Medium	High	High	Very high
Possible	Medium	Medium	High	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

In several articles such matrix has been sometimes criticized. In particular, Smith *et al.* (2009), have experimentally demonstrated for instance that [...‘*Human subjects exaggerate the influence of losses when the losses occur to their personal wealth*’...]. (We suppose that an opposite effect could occur when impersonal decisions regarding the general health, must be taken). In addition, these Authors showed that when probability is very low or very high a biasing effect occurs, deflecting its evaluation towards medium levels.

The risk matrix shows that the risk level depends on the probability of occurrence of the ‘negative event’ and the severity of the possible consequences. The ‘very high’ risk level is reserved only to the cases where both factors are at high or the highest level (the three purple cells in the top right corner of the Table).

According to us, the attention should not only be devoted to the ‘highest-highest’ and ‘lowest-lowest’ corners, leading to obvious evaluations, but mainly to the other two corners.

In fact, in those cases even an ‘extremely severe’ consequence is generally reduced to a ‘medium risk’ evaluation if a ‘low’ or ‘very low’ probability has been attributed to the event. Specularly, very likely events, characterized by low consequences, could be undervalued.

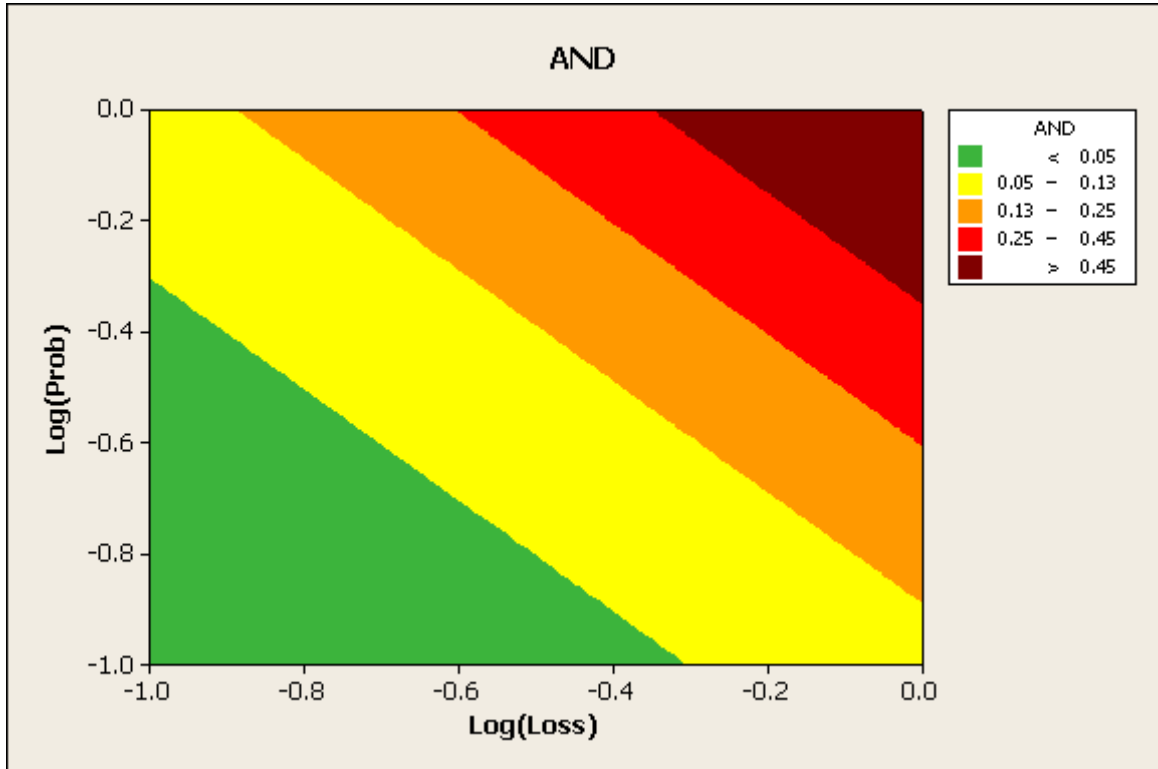
The relationship between the risk matrix and its analytical definition has been already noted by Cox (2008).

**The analytical measure of Risk**

Usually, Risk is analytically measured by using the following formula:

$$Risk = Probability \cdot Loss \quad (1)$$

Whenever it is possible to quantify the consequences as a *Loss* and normalize it in a [0, 1] interval, the contour plot of this function in log-log scale is presented in Figure 1. With an opportune choice of axes scales and contour levels, it is evident that the formula (1) can be assumed as the theoretical basis of the above mentioned risk matrix reported in Table 17.



**Figure 1. Contour plot of the function *Probability · Loss* in log-log scales.**

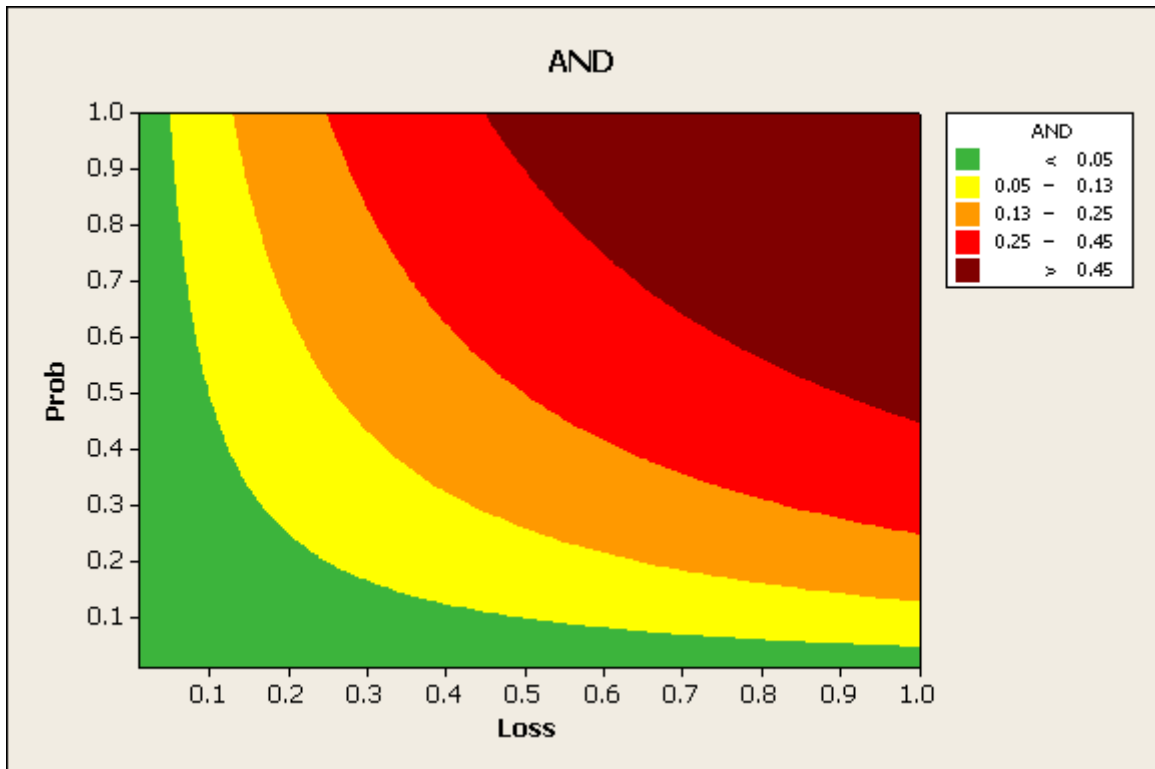
Range, number of levels and their limits can be arbitrarily assigned. For the plot in Figure 1, we chose them in order to obtain a picture similar to that in Table 1.

The measure of risk stated by (1) is based on the logical operator “AND”. The main aspects of such measure are the following:

- it is possible to reduce the risk level by appropriately reducing the probability of the event;
- very likely events do not entail high risk if their consequences are not severe;
- only likely AND severe events lead to extreme risk.

The drawbacks of such measure become obvious when the function (1) is plotted on natural scale axes, see Figure 2.

In this Figure limits are chosen in order to obtain five zones covering same area. Those limits are the same chosen in Figure 1.



**Figure 2. Contour plot of the function *Probability-Loss* in natural scale axes**

### **The concept of Probability in Risk measure**

The measure of Risk as *Probability* times *Loss* is universally accepted, but not always adopted. There are many cases diverging from this measure. A typical example of disagreement of everyday behavior from a probabilistic point of view concerns the choice of means of transport. Nobody of us will drive a car if we would consider the probability and the severity of consequences of an accident. In this case, since the probability is very low, people seem to not exactly understand what does unlikely mean.

This behavior is not only typical of human beings. Experiments carried out in aquariums showed that, until the ratio predatory/preys is low, fishes do not exhibit visible anxiousness.

Many examples can show the attitude of human beings, who are used to live in a dangerous environment, but are not paralyzed by fear. This attitude can lead individuals to afford high risks, but can allow species to survive.

What does Risk mean according to the “AND” logic? Particularly, what does “probability” mean?

A typical probabilistic statement is: ‘This event has a probability to occur once in a thousand years’. What does it mean? How many years we are now from the last occurrence?

This question is meaningless in a Poissonian world (remind the so called memory-less process) where the probability does not increase or decrease over time. The ‘event’ could either occur now or we should wait for more than expected.

The measure of Risk (1) can be also viewed as an expected cost (long-term mean), therefore it is acceptable only when “the mean is meaningful”, for instance when we handle amortizable figures. In fact Risk is appropriately seen as an expected cost when it is possible to ‘amortize’ an issue over several units (time, persons).

For example, saying “10% probability of paying a cost C” means that we expect 10 occurrences of the negative event out of 100 times, so we divide  $10 \cdot C$  by 100.

Another example: when using 100 bulbs in a row, it makes sense to sum up the lifetimes of each of them and to divide by 100 to estimate the mean life. In such a case, one long-life bulb can counter-balance several short-life bulbs. Conversely if it is necessary to use only one bulb, it is better to refer to the probability to reach an assigned time horizon. In a very asymmetrical distribution, as the Exponential one, governing memoryless processes, the probability of having an element with life-time less than the mean is the 62.3%. It means that we approximately expect that 2 bulbs out of 3 will fail before their mean life. For systems that can be modeled as “renewal processes” the mean lifetime can be used as a valid criterion, otherwise when a very high reliability is required, it is necessary to take into account more conservative percentiles.

In conclusion we think that the measure of Risk as a mean loss is in agreement with the manager’s perspective, i.e. a long term perspective, in which a today’s high cost can be amortized by several tomorrow’s low costs. This vision should never be used when non-replaceable elements are involved, like human (or living) beings, non-renewable environmental resources, and so on.

### An alternative measure of Risk

Doubtless, the mean is a very simple and attractive way to summarize variable quantities. Moreover the product *Probability* times *Loss* is very easy and manageable. Therefore, we wish to express a new measure of Risk that is as simple as the previous one, but avoiding the drawbacks discussed above.

We may define ‘Safeguard’ as the complement to one of the Risk and as the product of ‘improbability’ times ‘saving’, therefore:

$$Risk = (1 - Safeguard) = 1 - [(1 - Probability) \cdot (1 - Loss)] \quad (2)$$

The contour plot of the function (2) in natural scale axes is presented in Figure 3, using the same number of levels and limits of Figure 2.

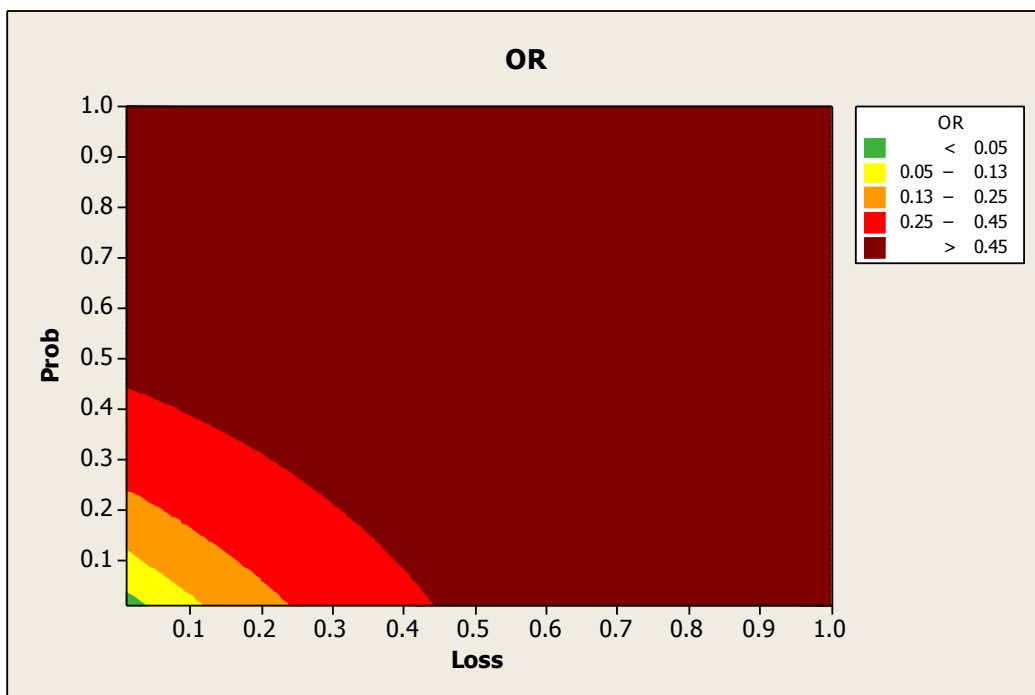
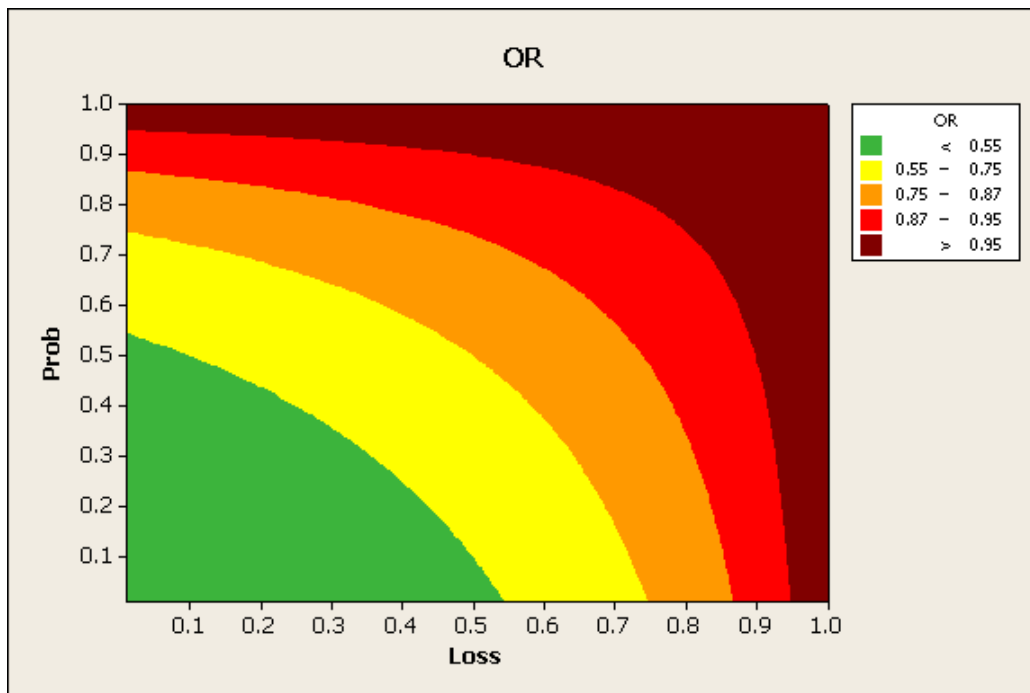


Figure 3. Contour plot of the Risk function expressed in (2)

By opportune rescaling, in order to obtain five almost equispaced zones, limits have to be changed. Hence Figure (4).



However any rescaling does only affect an absolute evaluation of risk, but not a relative evaluation, i.e. when comparing different alternative scenarios.

The advantages of the measure of Risk expressed by (2) are evident.

In fact:

- very frequent events must be evaluated as highly risky, even if their consequences are not severe;
- events with catastrophic consequences may never be associated to an acceptable level of Risk, even when their probability is judged as negligible;
- it is sufficient the presence of high severity of consequences (*Loss*) OR high probability of the negative event to lead to a high evaluation of Risk.

The last property is in line with the precautionary principle.

We are compelled to reduce both severity and probability (whenever possible) to have an activity that can be declared SAFE; this is a path towards a real continuous improvement process that cannot be stopped when one or another of the two terms is minimized.

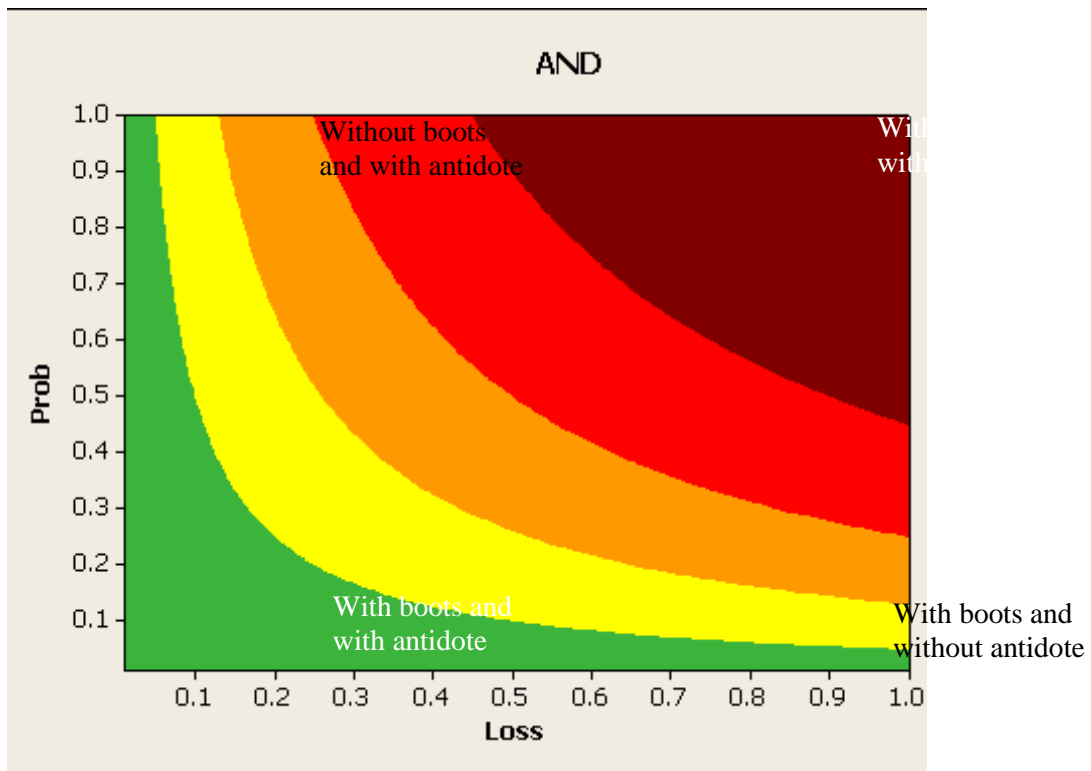
### An illustrative example

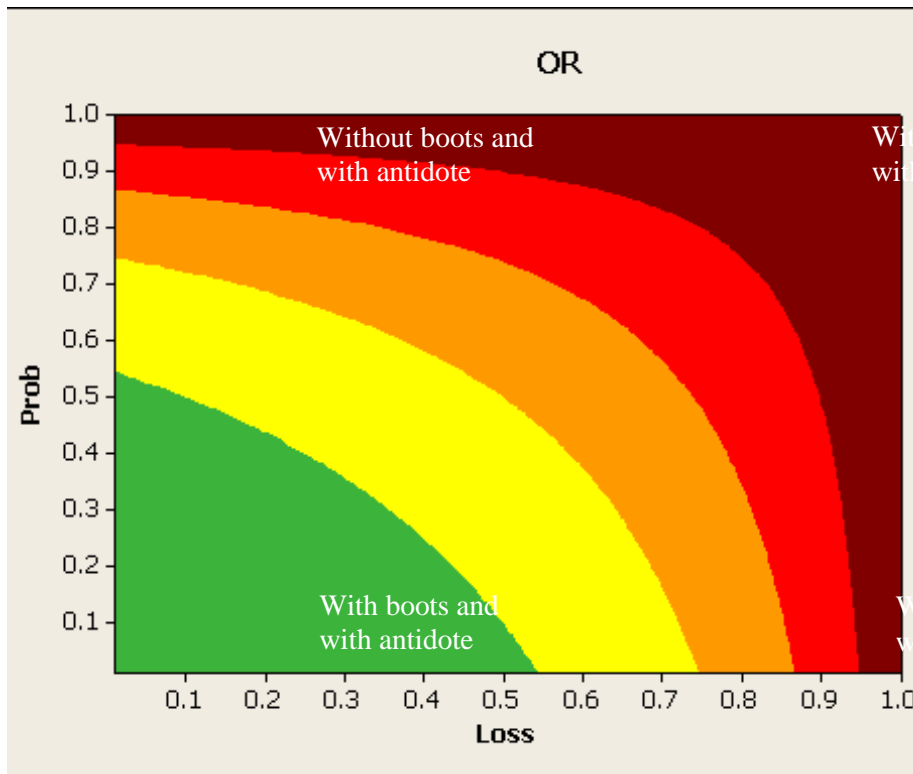
To clarify the difference on applying the two investigated measures, 'AND' and 'OR', we use an illustrative example: a walk in the countryside.

A possible danger when walking in the countryside is a viper bite. The consequences of the viper bite can be minimized using an antidote, while the probability of being bitten can be minimized by using boots.

According to the traditional 'AND' logic a very risky action is committed only when not using boots and not bringing an antidote. While it seems sufficient, for reducing the risk level to an "acceptable" one, to adopt just one precaution.

Conversely, according to the 'OR' logic here proposed, this is excluded. Not bringing an antidote OR not using boots keeps the level of risk at high levels. Only bringing antidote and using boots implies a low risk.





**Figure 4. Comparison of the Risk logics AND (Figure a) and OR (Figure b), through an illustrative example.**

## Conclusions

The ‘AND’ logic, directly deriving from the measure of Risk as ‘expected consequence’, i.e. the product of *Probability* times *Loss* is a simple and effective measure that can be used (and it is used) to give managers the ability to assess the risk level of an activity and then to rank possible alternatives. This logic, also expressed through a traditional Risk matrix, where both *Probability* and *Loss* are discretized in e.g. five levels, in our opinion may be appropriate only for central values of the two factors.

Also in the corners low-probability/low-loss, and high-probability/high-loss, the assessments are fairly obvious and do not show weaknesses.

However, when we consider the two other corners, such definition of risk has big drawbacks.

The first reason is that often low probabilities are not perceived or interpreted correctly. The second reason is that some phenomena are not amortizable. The AND logic can be defined as the “manager’s logic”, where it is possible to dilute a potentially catastrophic event, which can very rarely occur, over a high number of other, lucky or successful, cases. This logic often presides over the decisions of Authorities and it is far from those who actually pay the real losses.

The alternative logic and consequent measure of Risk, that we have proposed here, privileges the perspective of citizens, who are unable to offset the consequences of a catastrophic event that could invest them, and therefore must seek to avoid in any way actions that could lead to disasters, albeit with low probability.

As a last reflection, consider the insurance contracts. The basis of their attractiveness lies in the fact that they match the AND manager's logic used by the company having the possibility of amortizing adverse events over large numbers, with the OR citizen's logic who prefer to pay a fee (although higher than the expected loss), rather than afford an enormous expense even very unlikely.

## References

Cox L. A. Jr. (2008) "What's wrong with risk matrices?", *Risk Analysis*, Vol. 28, 2, 497-512

Haimes Y. Y. (2009) "On the complex definition of risk", *Risk Analysis*, Vol. 29, 12, 1647-1654

Kaplan S., Garrick B. J., (1981) "On the quantitative definition of risk", *Risk Analysis*, Vol. 1, 1, 11-27

Smith E. D., Siefert W. T., Drain D. (2009) "Risk matrix input data biases", *System Engineering*, Vol. 12, 4, 344-360

Weber E. U., Milliman R. A. (1997) "Perceived risk attitude: relating risk perception to risky choice?", *Management Science*, Vol. 43, 2, 123-144

Wood O. J. Jr (1964) "Evolution of the concept of risk", *The Jour. Of Risk and Insurance*, 83-91