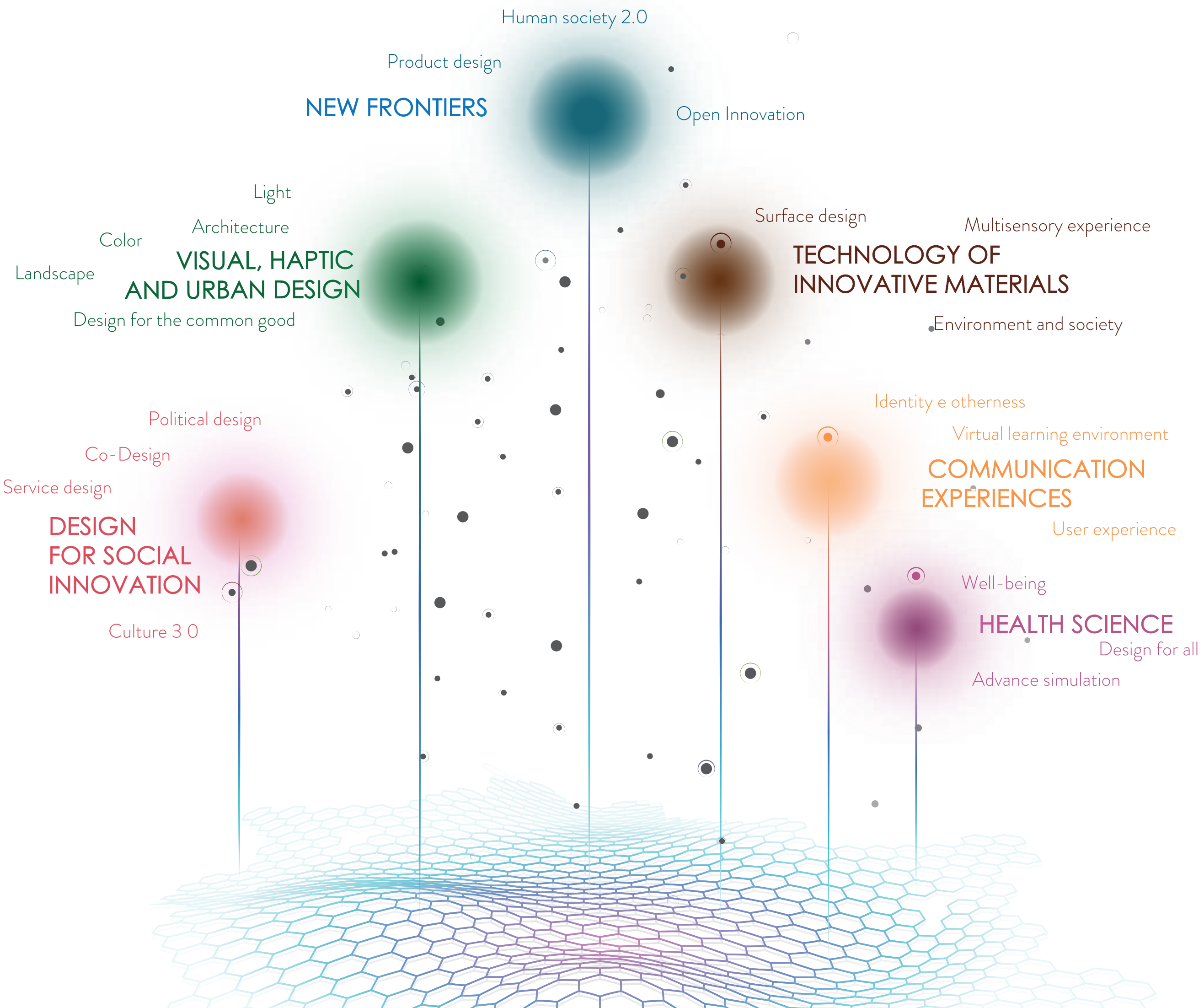

3rd International Conference on Environmental Design

3-4 October | Marsala - Sicily

MDA
MEDITERRANEAN DESIGN ASSOCIATION

PALERMO UNIVERSITY PRESS

III^rd International Conference on Environmental Design
A cura di Mario Bisson

Proceedings (reviewed papers) of the IIIrd International Conference on Environmental Design,
Mediterranean Design Association | www.mda.center | workgroup.mda@gmail.com
03-04 October 2019, Marsala, Italy

Progetto grafico ed impaginazione: Martino Zinzone
Immagine di copertina: Mario Bisson | Martino Zinzone

PALERMO
UNIVERSITY
PRESS

ISBN STAMPA: 978-88-5509-060-5 | ISBN ONLINE: 978-88-5509-063-6

Viale delle Scienze, Edificio 16 (c/o ARCA) | 90128 Palermo
Published in September 2019

3rd International Conference on Environmental Design

Conference proceedings

Organization

Scientific Committee

With the patronage of:

POLITECNICO MILANO 1863 SCUOLA DI DESIGN

UNIVERSITÀ DEGLI STUDI DI PALERMO

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Special thanks to:

Giorgio Di Crescienzo for supporting the translation of the introductory contribution

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Introduction to the Conference

MARIO BISSON : Scientific Director

"Transdisciplinarity is the -intellectual space- where the nature of the manifold links among isolated issues can be explored and unveiled, the space where issues are rethought, alternatives reconsidered, and interrelations revealed."

(UNESCO – Division of Philosophy and Ethics, 1998)

According to UNESCO's definition, transdisciplinarity is the intellectual space where the connection among isolated topics can be explored and unveiled.

Thus, transdisciplinarity represents the ability to create synergies between different knowledge areas on common objectives. If this happens, the addressed complexity is superior to any discipline that operates in an autonomous manner; it connects people, it builds a new way of approaching criticalities, and increases personal competencies.

Fragmentation between disciplines, the concept of specialized expertise, is today less and less actionable, it must be considered outdated.

In order to address modern complexity, the high number of information and the criticalities to which we are continually exposed to, creating integration processes that go beyond the simple monodisciplinarity is fundamental.

Today, we find in the transdisciplinary approach the tool with which we can address new challenges, the way in which different disciplines cooperate in order to reach an ultimate goal, overcoming the multidisciplinary and interdisciplinary approaches adopted until now.

In interdisciplinarity, disciplines change in their concepts or tools by means of others. In this approach, disciplines that cooperate and change are disciplines close to each other; these are disciplines that have meeting and joining points by nature.

The term transdisciplinarity[1] was, instead, born in 1970 thanks to Jean Piaget, a Swiss psychologist, philosopher and biologist. The given definition outlines an approach that overcomes and interweaves different disciplines; it comes from rejecting fragmentation of knowledge in order to reach an integrated ad unified understanding of the world.

Have you noticed how new disciplines, so-called frontier disciplines, are ever-developing?

Mechatronics, biotechnologies, etc. all come from engaging two sciences, from the genius of individuals that were capable of merging them and getting them to talk to each other; individuals that were able to seize and manage to the best the complexity of certain phenomena and the diversity of several disciplines, creating a synergy among them, giving life to something new. Analyzing elements and solving problems left in the dark so far was possible only by merging different points of view. This very synergy distinguishes the transdisciplinary approach from the previous ones; the multidisciplinary and interdisciplinary ones.

In the transdisciplinary approach you don't have a simple sum of disciplines, but a reciprocal cooperation and modification.

The transdisciplinarity of environmental design is the strategic key to make the integration into a system of the environmental, social and economic aspects possible, in that it satisfies the need to involve and coordinate, in every phase of the configuration of the future, the researchers of different knowledge areas in order to configure a whole where everyone gets and gives knowledge, as a means of innovation.

But what does innovation mean? The dictionary suggests: «mutating a system implementing something new: ideas, points of view».

This definition does not exhort, nor imposes, a change in technology, like industrial tradition got used to; if anything, it illustrates the inclusion of a new vision in a system, a new way of approaching reality. Thus, innovation does not lie in continuous technologic upgrades, but instead in the change of perspective from which issues are observed. Innovation does not involve studying or perfecting a technologic aspect, but in constant research through design culture. It is therefore necessary to change approach on issues and start from the assumption of getting to talk, dialogue, compare different scopes: design, industry, politics, environment, society, economics, etc.

None of these scopes are autonomous, they all are in strict correlation and interdependence, forming a system, a whole that is «constituted of several interdependent elements, joined together organically» by definition.

In this moment in history, we are in contact with machines filled with data: data of various kinds, about different subjects and topics, but always interconnected. Maybe this is one of the reasons why among future skills the necessity to develop the so-called transdisciplinarity is growing. Knowledge is not unified anymore: we stand before a huge number of sources that give back a complex reality for which the simple juxtaposition of disciplines does no longer suffice. A different, more articulated, more integrated and interconnected approach in "problem solving" of complex situations is needed, precisely a transdisciplinary one.

This approach is also the cornerstone of MDA's (Mediterranean Design Association) activity, an association born in Agrigento in 2013, that poses as its objective the development of research activity through a new scientific and cultural approach, based, obviously, on transdisciplinarity, conferred by the reciprocal and continuous influence of different extant sciences.

Progress demands research, studying the existing with an eye to the future that can lead to the birth of new scenarios; we constantly talk about environment, pollution, traffic, consumption: we complain, discuss it with friends, but don't always really participate. The conference on environmental design is only a way to start divulging how much research does in several fields, on different levels: from the scientific from the public one, from the business to the social one. Discussing, analyzing, suggesting is the only way to deal with the future in a constructive and integrated way. The scientific excellencies that were invited, coming from different parts of the world and from illustrious research centers, are called to discuss, listen and suggest new thoughts; the same possibility is given to new researchers, giving a moment to expose, on an international plane, the advancements of their own research.

All this becomes a chance of participation and confrontation that is useful to the vision that MDA has set itself since the start: improving the quality of life…

Notes

1. J. PIAGET, L'épistémologie des relations interdisciplinaires, in AA.VV., L'interdisciplinarité, pp. 141-144 (trad. it. in J. Piaget, J.S. Bruner et AL., Pedagogia strutturalista, Torino, Paravia 1982, cap. IV da p. 131). Unlike interdisciplinary ones, multidisciplinary relationships establish themselves when "the solution to a problem requires information from two or more sciences […] without, however, having the disciplines modified or enriched by the ones used"; transdisciplinarity makes "links in a system that's totally devoid of stable boundaries between disciplines" possible. About interdisciplinarity, it's good to keep in mind the following quote, extrapolated from Le scienze dell'uomo: "the acquired techniques in a natural science 'can be' able to directly clarify what was necessary to build to solve a complex problem, fundamental for the sciences of man" (J. PIAGET, Le scienze dell'uomo, Universale Laterza, Bari 1983, p. 81).

A possible tool for the choice of building materials: the environmental product declaration (EPD)

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KEYWORDS:

| *Environmental product declaration*
| *Product construction rules*
| *LCA*
| *ISO 14025*
| *Material construction*

Abstract

The paper, contribution to the international debate on the environmental matter, deals with a tool that can guide professionals and the users in choosing low environmental impact building materials with similar functional requirements, the Environmental Product Declaration (EPD) or Type III Environmental Label, by highlighting strengths and limitations. The paper, besides describing the characteristics and contents of the EPDs and Product Category Rules (PCR), lists the main European EPD Programmes, analyzing two EPDs models in order to verify the comparability of the listed LCA data.

Introduction

In general, process, production/creation and product innovations are fostered by the (European, national and local) legislation – nowadays mostly on the environmental subject – and by market mechanisms that stimulate a productive competition for the professionals on the continuous enhancement of the product compared to a constantly changing demand made by planners, builders, buyers and final users. The difficulty of the subject corresponds to a quite complex framework of environmental directives – somehow still fragmented – requiring quite a massive effort to be implemented and most of all to verify the environmental effectiveness of the strategies enforced over the last few years. A first attempt at a systemic approach can be found in the Europe 2020 Strategy and in particular in A Resource Efficient Europe objective (European Commission, 2011a, 2011b), which provides for the delineation of a set of economic-financial tools to assess the real costs and benefits of the use of resources and to encourage the use, in the long run, of solutions designed to an efficient use of natural resources.

It is established that the environmental subject is heavily affected by the building sector, which can play a decisive role in containing CO2 emissions in the atmosphere given that globally in 2017 the building industry consumed 36% of energy and was responsible for almost 40% of carbon dioxide emissions (UN Environment, 2018). These percentages are referred to the total energy used by the building, that is the sum of operational energy and embodied energy that contribute to the calculation of the total energy (Barucco et alii, 2016; Gonzalez & Navarro, 2006; Treloar et alii, 2001). More specifically, the emissions of buildings can be divided into three fields: direct emissions, coming from the burning of fossil fuels in buildings; indirect emissions, coming from the production of electrical and thermal energy; the embodied carbon or CO2 emissions, coming from the production of materials. While direct and indirect emissions tend to decrease, the emissions coming from the production stage of materials are becoming increasingly important, especially those related to steel and cement which, from 1.8 gigatons of carbon dioxide (GtCO2) released in 2017, will increase up to around 40% by 2060, according to the recent projections provided by the International Energy Agency (IEA, 2019). Therefore, the environmental issue, if referred to the building sector, traditionally well-structured and complex, highlights that it is increasingly necessary to create a system of the regulatory framework and of support decisional tools and to evaluate the environmental efficiency of materials and building components, innovative technologies and building techniques that can make an important contribution to the sustainability and eco-efficiency of the building industry (Pacheco-Torgal & Jalali, 2012). The need for a simplified approach, for quick use by the professionals and for a certain verification by the inspectors, in recent years has fostered the dissemination of tools with checklists – protocols or system rating with grades like LEED, BREEM, ITACA, etc. – or of minimum environmental criteria for Green Public Procurement, based on a very detailed list of environmental criteria-requirements to comply with in order to be awarded or in order to access to tenders, in the case of the general public (Ganassali et alii, 2016). Overcoming this typically qualitative attitude – on the basis of reasoned and grouped into class parameters – and the need for a verification of environmental effectiveness in strictly quantitative terms, in recent years, have pushed the standardization Structures at international (ISO), European (CEN) and national (UNI) level to the implementation of tools, such as Life Cycle Assessment (LCA), capable of quantitatively measuring resource flows and environmental impacts throughout all stages of the life cycle, the increase or reduction of environmental impacts related to process and product innovations.

The goal of reaching high performances of the materials concerning for to environmental indicators, despite the complexity of the required framework to which the project must respond, gives to the project a double challenge. The first one is the relationship between the project and the matter: the research started over the last few years on the bio-based materials (Sposito & Scalisi, 2019; Maskell et alii, 2015; Onchiri et alii, 2014) are emblematic of the possibility of designing the characteristics of the materials not only from a technical performance – as for the advent of composite materials – and aesthetic point of view, but also from the environmental performance point of view. The second challenge concerns the opportunity to optimize the production processes of materials to reduce the most expensive stages from the point of view of resource consumption and generated impacts (Campioli et alii, 2018), enhancing 'low energy consumption' solutions. In this context, a useful tool for assessing the environmental impacts of materials is the Environmental Product Declaration (EPD) which aims to contribute to reducing the impact on climate of the building sector by encouraging planners and designers to use the LCA while planning and designing buildings (Bovea et alii, 2014; Pacheco-Torgal, 2014; Del Borghi, 2013). This paper illustrates the main features of the EPD and its dissemination, focusing in particular on the analysis of two Environmental Product Declarations relating to Laminated Wood material, produced by two different EPD Programmes, highlighting their strengths and limitations.

The Environmental Product Declaration (EPD) and the Product Category Rules (PCR)

The Environmental Product Declaration (EPD) is one of the most recommended methods to report the environmental impacts of building materials (Kuittinen & Linkosalmi, 2015). EPD is a certified environmental product declaration that provides environmental data on the life cycle of products in accordance with the international standard ISO 14025 (2006), is «[…] the input for a holistic building assessment considering the functional and technical performances in a building context. For a producer, this also means that his contribution to higher sustainability (environmentally, socially and economically) of course should be done by big and small improvements on every step in the building chain» (Gagari et alii, 2013, p. 107). It is a voluntary project decided by the companies that through this tool can communicate the environmental data of their products. These data are processed by one or more Organizations, based on Life Cycle Assessment (LCA) in accordance with the ISO 14040 (2006) series of standards and are independently verified.

Therefore, the LCA method can provide important information on the stages of the whole life cycle to reduce environmental loads and impacts, also through the use of open access software (OpenLCA, 2019; SimaPro, 2019). This is why many Green Building Rating Systems have added LCA indicators in the criteria relating to materials and have fostered the use of products with EPD certification, allowing to identify the best material during the design stage based on verified environmental information. It should be noted that only one protocol, the German DGNB (2019), was born with the LCA evaluation of the building among the first criteria of the protocol, virtuously activating the whole supply chain and leading to a quick increase of EPD certified products, favouring the elimination of irrelevant and misleading data and enhancing primary data strictly linked to the specific product used in the building, stimulating the production sector to direct competition and environmental innovation of products. The general objective of EPD is to encourage the demand and supply of products entailing less stress on the environment while allowing the comparison between products that have the same function. The ISO 14025 (2006) standard establishes nine guidelines of the EPD in the following points: relationship with the ISO 14020 Standard (2000), voluntary nature, life cycle basis, modularity, the involvement of the interested parties, comparability, verification, flexibility, transparency.

	BUILDING LIFE CYCLE INFORMATION																Supplementary information beyond the building life cycle
	A1-3			A4-5		B1-7							C1-4				D
	Product stage			Construction process stage		Use stage							End of life stage				Benefit and loads beyond the system boundary
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Raw material supply	Transport	Manufacturing	Transport	Construction	Use	Maintenance	Repair	Replacement	Refurbishement	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse Recovery Recycling potential
				Scenarius		Scenarius							Scenarius				
Cradle to gate	M	M	M														
Cradle to gate with options	M	M	M	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Cradle to grave	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	O

M = Mandatory O = Inclusion Optional

T1

T1
Table 1: Information modules for construction products, adapted from EN 15804:2012.

The Environmental Product Declaration is also known as a Type III Environmental Label, according to the classification of the International Standards Organization (ISO) which divides environmental labels into three types: the type I label describes the impact of products or services on the environment, its acquisition is voluntary-based and is regulated by ISO 14024 (1999); the type II label consists of self-declared environmental declarations of companies and organizations without third-party verification and is regulated by ISO 14021 (1999); Type III label or Environmental Product Declaration label is regulated by ISO 14025 (2006).

The developing process of an EPD consists of four stages: 1) the selection of type II Environmental Declaration Programmes; 2) the research of Product Category Rule (PCR) for the product that must be declared (if there is not a Product Category Rule for the product category, it must be created); 3) the creation of a EPD draft based on the implementation of the LCA method, abide by the rules of the EPD Programme and the outlining of a specific PCR for that product category; 4) the verification process that has to prove, before the EPD publication that the data collection and the enforcement of the LCA method are made according to the PCR and meet all ISO requirements.

The EN 15804 (2012) standard specifies the basic rules for EPDs relating to the category of building materials, as a guarantee that all Declarations are uniformly represented and verified. Specifically, the Product Category Rule (PCR) must list the stages of the life cycle to be included, the parameters to comply with and how the parameters must be collected and reported. The life cycle stages are established by the EN 15804 (2012): Product stage, Construction stage, Use stage, End of life stage, and an optional module Reuse-recovery (D). In Table 1 the mandatory and optional stages are listed, according to the system limit considered: the 'cradle to gate' analysis evaluates only the Product stage (A1-A3), which is therefore mandatory; in the 'cradle to gate with options' analysis, the Product stage (A1-A3) is mandatory while all other stages are optional; in the 'cradle to grave' analysis all stages are mandatory except D) which is optional.

Contents of the Environmental Product Declaration and EPD Programmes

The Environmental Product Declaration (EPD) has to facilitate the comparison between products' environmental characteristics that meet equivalent functional requirements. The information included basically concerns: identification and description of the organization that makes the declaration; the product description; the name of the programme and the address of the programme manager and, if necessary, the logo and website; the identification of the PCR; the publication date and the validity period; Life Cycle Analysis data (LCA); additional environmental information; the presence of materials and substances that must be declared, for example substances that can negatively affect public health and the environment at all stages of its life cycle; information on the stages that have not been taken into consideration, if the declaration is not based on a 'cradle to grave' LCA.

The LCA results are divided into three categories on Environmental Impact, Use of Resources, Output Flows and Waste Categories. The Environmental Impact includes the parameters relating to the global warming potential, stratospheric ozone layer depletion, soil and water acidification potential, eutrophication potential, tropospheric ozone and photochemical oxidants formation potential, abiotic degradation of non-fossil resources potential, abiotic degradation of fossil resources potential. The Use of Resources includes the parameters on the use of: renewable primary energies as an energy source; renewable primary energy resources as raw materials; renewable primary energy resources; non-renewable primary energies as energy sources; non–renewable primary energy resources such as raw materials; non-renewable primary energy resources; secondary materials; secondary renewable fuels; non-renewable secondary fuels; net consumption of water resources. In the Output Flows and Waste Categories, the following parameters are included: hazardous waste disposed of, non-hazardous waste disposed of, radioactive waste disposed of, components destined for re-use, materials destined for recycling, materials destined for energy recovery, exported electricity, and exported thermal energy. Finally, additional information on environmental issues can be provided such as the potential impact on biodiversity or the assessment of risks to public health and the environment.

Among the many independent Organizations or Highly Organized Structures that develop the EPD, it is certainly worth mentioning the International EPD® System which, established in 1999, was the first EPD programme developed on a global scale and still is one of the most widespread in Europe (Hunsager et alii, 2014). Table 2 lists the 14 most important EPD Programmes in Europe – sorted by the number of EPDs processed – almost all created for the building materials certification, except for the EPD-Norge and the International EPD System. The data in the Table, if compared with the numbers shown in previous studies (Bovea et alii, 2014), show a significant increase – from 2014 to date – of the EPDs that have increased from 249 to 634 in the International EPD® System and from 280 to 1751 in the IBU – EPD, as a reaction from

T2
Table 2: EPD Programmes: Construction Products (Access 29 aprile 2019).

EPD PROGRAMMES	LINK	NUMBER OF EPDs	COUNTRY
FDES INIES	www.hqegbc.org/accueil/	2746	France
IBU-EPD	ibu-epd.com/	1751	Germany
International EPD® System	www.environdec.com	634	Sweden
EPD-NORGE Norwegian EPD Foundation	www.epd-norge.no	500	Norway
EPD Ireland	www.igbc.ie/epd–home/	97	Ireland
MRPI®	www.mrpi.nl/	74	Holland
BRE	www.greenbooklive.com	70	United Kingdom
EPDItaly	www.epditaly.it/	50	Italy
RTS EPD	epd.rts.fi/en/	37	Finland
EPD Danmark	www.epddanmark.dk/site/index.html	33	Denmark
DAPconstrucción®	www.csostenible.net/home/index?locale=es	21	Spain
DAPHabitat System	daphabitat.pt/	11	Portugal
ZAG	www.zag.si/si/	9	Slovenia
Bau EPD	www.bau–epd.at	6	Germany

T2

the world of producers to a new sensitivity towards eco-oriented materials and building components by the users.

Case Studies

This paper has examined two of the main EPD Programmes, the International EPD® System and the IBU-EPD. The choice has quantitative reasons justified by the fact that the first one is the most widespread in Europe while the latter has a considerable number of EPDs – the second after the French FDES INIES – but above all, it reports the greatest number of PCR elaborated by an EPD programme in Europe. The first difference between the two Programmes can be found in the field of the processed products: while the IBU-EPD deals exclusively with building materials, the International EPD® System has also other categories, as Food & Beverages, Chemical Products, Textiles, Footwear & Apparel, Paper Products. The number of the products in the archive is also different: the IBU-EPD has 1749 building materials while the International EPD® System 634, even if the latter can be found in more Countries (25 in Europe alone).

PCR	Sub-PCR
Construction products and construction services	PCR 2012:01 – Sub-PCR-A Mortars applied to a surface
	PCR 2012:01 – Sub-PCR – B Synthetic carpet yarn
	PCR 2012:01 – Sub-PCR – C Acoustical systems solutions (previously: Acoustic ceilings)
	PCR 2012:01 – Sub-PCR – D Bricks, blocks, tiles, flagstone of clay and siliceous earths
	PCR 2012:01 – Sub-PCR – E Wood and wood-based products for use in construction (EN 16485)
	PCR 2012:01 – Sub-PCR – F Resilient, textile and laminate floor coverings (EN 16810)
	PCR 2012:01 – Sub-PCR – G Concrete and concrete elements (EN 16757)
	PCR 2012:01 – Sub-PCR – H Cement and building limes (EN 16908)
	PCR 2012:01 – Sub-PCR – I Thermal insulation products (EN 16783)
	PCR 2012:01 – Sub-PCR – J Instant boiling and chilled drinking water dispensers (permanently installed)
	PCR 2012:01 Sub-PCR-K Rehabilitation Services of highways, streets and roads

T3

T3
Table 3: PCR e sub-PCR developed by the International EPD® System (processed data on 29 April 2019).

Concerining the Product Construction Rules, it is worth mentioning that the International EPD® System has developed a PCR entitled Construction Products and Construction Services, and 11 Sub-PCR concerning different materials categories (valid on the access date of 29 April 2019), shown in Table 3. The IBU-EPD has developed 105 PCR divided into three large groups called 01) Basic Materials and Precursors, 02) Building Products, 03) Building Services Engineering, in which we can find some sub-groups. For instance, the group 01 Basic Materials and Precursors includes 4 sub-groups called 'Aggregates', 'Cement, building limes and other hydraulic binders', 'Other basic materials and precursors', 'Products related to concrete, mortar and grout'. Within the sub-groups, we can find the PCRs of the materials, as shown in Table 4. It should be noted that some materials with the same PCR are in the same subgroups, useful expedient to ease the research within the database; among others, we mention the Bulk granulate, both in the sub-group 'Aggregate' and 'Products related to concrete, mortar and grout'

	PCR	
01 Basic materials and precursors	Aggregates	- Natural aggregates - Bulk granulate - Processed fly ash
	Cement, building limes and other hydraulic binders	- Cement
	Other basic materials and precursors	- Synthetic carpet yarns - Synthetic granulate
	Products related to concrete, mortar and grout	- Bulk granulate - Concrete admixtures

T4

T4
Table 4: PCR and sub-PCR developed by IBU-EPD (Access 29 April 2019).

Further analysis has been carried out on the LCA found in the EPDs of the material called Laminated Wood – of which, for confidentiality reasons, the manufacturing companies are not mentioned (see: www.ibu-epd.com; www.environdec.com) – developed by the two Programmes (Tables 5, 6 and 7). Specifically, EPD developed by the International EPD® System based on the PCR '2012:01 – Construction products and construction services Ver 2.2' and on the Sub-PCR 'Wood and wood-based products for use in construction' (EN 16485), while the one developed by IBU-EPD is based on PCR 'Solid wood products'. Both documents describe the field and objective of the LCA and establish the parameters for the assessment of the environmental performances necessary for the development of an EPD for the group of 'wood' products. What immediately seems clear is the different limit of the system used in the two cases. In the case of the EPD developed by the International EPD® System, the mentioned limit is Cradle to Gate, therefore exclusively related to Module A1A3 (Product stage), while in the case of the IBU-EPD the life cycle assessment refers to a Cradle-to-Gate with Options analysis, which takes into consideration the different stages of the life cycle Module A1-A3 (Product stage), Module C3 (Waste processing); Module D (Benefits and impacts beyond the system boundaries).

T5
Table 5: Environmental Impact of the Laminated Wood. EPDs developed by the International EPD® System and by the IBU-EPD (Access 29 April 2019).

T6
Table 6: Use of Resources of Laminated Wood. EPDs developed by International EPD® System and by the IBU-EPD (Access 29 April 2019).

LAMINATED WOOD ENVIRONMENTAL IMPACT								
PARAMETER	UNIT	INTERNATIONAL EPD® SYSTEM				IBU-EPD		
		A1	A2	A3	A1-A3 TOT	A1-A3	C3	D
Global warming potential (GWP)	kg CO_2 eq.	-913,886	11,850	2,682	-899,354	-6.46E+2	7.67E+2	-4.12E+2
Acidification potential (AP)	kg SO_2 eq.	0,923	0,048	0,018	0,989	8.40E-1	0.00E+0	4.77E-1
Ozone depletion potential (ODP)	kg CFC 11 eq.	2,92E-05	2,16E-06	4,16E-07	3,18E-05	2.56E-5	0.00E+0	-1.08E-9
Eutrophication potential (EP)	kg PO_4^{3-}eq.	0,102	0,008	0,003	0,113	1.70E-1	0.00E+0	1.29E-2
Formation potential of tropospheric ozone (POCP)	kg C_2H_4 eq.	0,106	0,002	0,001	0,108	1.03E-1	0.00E+0	8.97E-2
Abiotic depletion potential – Elements	kg Sb eq.	1,55E-03	4,65E-05	2,17E-05	1,62E-03	1.01E-4	0.00E+0	-1.40E-4
Abiotic depletion potential – Fossil resources	MJ,net calorific value	2074,439	189,325	56,380	2320,144	1.34E+3	0.00E+0	-5.52E+3
Water scarcity potential	m^3 eq.	3,117	0,035	0,018	3,170	NO DATA		

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LAMINATED WOOD USE OF RESOURCES								
PARAMETER	UNIT	INTERNATIONAL EPD® SYSTEM				IBU-EPD		
		A1	A2	A3	A1-A3 TOT	A1-A3	C3	D
Primary energy resources – Renewable TOT	MJ, net calorific value	30102,20	2,35	2,94	30107,50	1.13E+4	-7.67E+3	-1.71E+3
Use as energy carrier	MJ, net calorific value	17296,20	2,35	2,94	17301,49	3.65E+3	0.00E+0	-1.71E+3
Used as raw materials	MJ, net calorific value	12806	0	0	12806	7.67E+3	-7.67E+3	0.00E+0
Primary energy resources – non-renewable TOT	MJ, net calorific value	3082,79	192,53	61,80	3337,13	1.50E+3	-1.30E+2	-7.42E+3
Use as energy carrier	MJ, net calorific value	2693,51	192,53	59,50	2945,55	1.37E+3	0.00E+0	-7.42E+3
Used as raw materials	MJ, net calorific value	389,283	0	2,3	391,58	1.30E+2	-1.30E+2	0.00E+0
Secondary material	kg	0	0	0	0	0.00E+0	0.00E+0	0.00E+0
Renewable secondary fuels	MJ, net calorific value	0	0	22,05	22,05	0.00E+0	0.00E+0	7.67E+3
Non-renewable secondary fuels	MJ, net calorific value	0	0	0	0	0.00E+0	0.00E+0	1.30E+2
Net use of fresh water	m^3	3,12	0.04	0.02	3.17	2.49E+0	0.00E+0	-1.73E+0

T6

The case study allows underlining the difficulty of comparing materials of the same type, in this specific case Laminated Wood, highlighting the system boundaries used (also because the case study is not an exception). We can compare only the results of the modules common to both (for this comparison we refer to the following study, since in this paper we have focused only on the comparison of the system boundaries), without being able to examine the others used only by one of the EPDs, a limit that makes an exhaustive and well-founded comparative evaluation difficult.

T7
Table 7: Use of Resources of Laminated Wood. EPDs developed by International EPD® System and by the IBU-EPD (Access 29 April 2019).

LAMINATED WOOD WASTE PRODUCTION AND OUTPUT FLOWS								
		INTERNATIONAL EPD® SYSTEM				IBU-EPD		
PARAMETER	UNIT	A1	A2	A3	A1-A3 TOT	A1 – A3	C3	D
WASTE PRODUCTION								
Hazardous waste disposed	kg	2,82E-03	1,16E-04	3,30E-05	2,97E-03	3.68E-5	0.00E+0	2.21E-6
Non-hazardous waste disposed	kg	26,982	18,533	7,636	0,813	3.84E+0	0.00E+0	1.71E-1
Radioactive waste disposed	kg	1,36E-02	1,22E-03	2,36E-04	1,50E-02	5.16E-2	0.00E+0	-7.55E-1
OUTPUT FLOWS								
Components for reuse	kg					0.00E+0	0.00E+0	0.00E+0
Material for recycling	kg					0.00E+0	0.00E+0	0.00E+0
Materials for energy recovery	kg					0.00E+0	4.64E+2	0.00E+0
Exported energy, electricity	MJ					0.00E+0	0.00E+0	0.00E+0
Exported energy, thermal	MJ					0.00E+0	0.00E+0	0.00E+0

T7

Conclusions

The current regulatory framework (Regulation 305/2011/UE on construction products, ZEB directive, CEN standards, GPP, etc.) and the many operational tools available (environmental assessment protocols, EPD certification, etc.), fostered by different bodies and born in different contexts and with different purposes, although worthy of having started a sustainability programme in building, they often appear in competition/conflict, generating confusion and disorientation among stakeholders. The environmental subject is often dealt with in a fragmentary way through the breakdown into sub-themes that leads to seek the optimization of some aspects to the detriment of others, without a systemic approach. One of the environmental certification tools that the building sector can use to address the environmental issue and to communicate the environmental performance of its materials and components, but also to convey the process and product innovation, as reported in this paper, can be supplied by the Environmental Product Declaration, regulated by ISO 14025 (2006).

The need to be more transparent on environmental information (Campioli & Lavagna 2013) is mandatory and can no longer be avoided, and in this regard, the increase of EPDs published over the last few years underlines this aspect. One of the basic characteristics of the EPD is the possibility of comparing the environmental aspects of the evaluated products, as in the examination of the case studies. However, as it is highlighted in this paper, this can happen correctly only if the same system boundaries are taken into consideration. Despite the efforts dedicated to the standardization of the declaration rules, especially with the implementation of EN 15804, this aspect must be considered more carefully.

Among the subjects that can benefit from it, we include the producers, who can transparently declare the environmental performance of their products, the designers, who can select material also based on its environmental profile, and the users, whose purchases can be more informed and respectful of the environment. Since it is a voluntary-based tool, understanding the reasons that can push manufacturers to use it is important. According to a study published in 2016 (Ibáñez-Forés et alii, 2016), 80% of producers state that the greatest limitation of the EPD lies in the fact that many users still do not know this tool, while its strength lies in the objectivity of the results reported and in the fact that using this tool improves the image of the company. Therefore, the dissemination of EPDs has not to be taken for granted because, on the one hand – to paraphrase Sinopoli and Tatano (2012) – the tool is taken in slowly before being able to change long-established practices, on the other, it must deal with limited knowledge or reticent professionals.

In Italy, an important boost to the dissemination of EPDs can come from the National Action Plan on Green Public Procurement (NAPGPP) which, the Italian Ministerial Decree of 11 October 2017 took into effect the Minimum Environmental Criteria (CAM) for public works (MATTM, 2017). These Criteria, among other things, establish the percentages of materials built with, even partially, recovered or recycled materials, which can also be declared through a Type III Environmental Product Declaration. Actually, two recent surveys on the implementation of CAMs – in the first (short) reference period – do not show a prompt response from the Public Administration: the first survey reports that in 2017 on a sample of 40 Municipalities having organized 119 tenders linked to building, only 6 (5%) have included CAMs among the project requirements (Point 3 and Associazione dei Comuni Virtuosi, 2019); the second report, led by the Osservatorio Appalti Verdi of Legambiente on a sample of 54 administrative centres, reports a slightly higher percentage, 7.1% (Nuova Ecologia, 2018). Both data are definitely not satisfactory, but we must take into account that we are in a transition stage in which, despite the Contract Law explicitly refers to the use of CAMs, their implementation clashes with the lack of preparation of the Technical Offices on handling them while evaluating the offers (since there are no official price lists or reference analysis) and with the necessary revision of the economic frameworks of the already planned works.[1]

'Innovative', 'advanced', 'nanostructured' or 'resilient' are adjectives expressing a change referred to new ways to create and develop materials, components and building systems that today must necessarily be 'eco-friendly', for which the project can be a great driver, provided that its potential is understood and its effectiveness optimized (Lucarelli et alii, 2012). The complexity of the building system, due to the relationships between the different sub-systems and between them and the whole building, requires accurate and detailed planning, capable of optimizing «at the same time technologies [...] that are very different» (Campioli, 2011, p. 64) towards a single purpose: the sustainability of the 'building system'. Maria Chiara Torricelli has the same opinion (2017, p. 24), as she states: «The acceleration in technological innovations from other scientific and industrial areas has shifted the role of technological skills from those who systematize and design technology to those who know how to interpret it, finalize it, use it and make it work in the complex system of the design».

Therefore, EPDs can be an important starting point to develop a new approach towards the project. They can have a significant influence on the evolution of environmental awareness in the building industry, calling design to define technical-building choices with a more sustainable environmental and energy profile, but mostly giving, in every decision-making step, a central role to the environmental impact of the entire life cycle of materials, components and building systems. At the same time, the EPDs can be an excellent lever both for greater and more aware qualifications of designers and companies and for the economy of the sector in increasing the turnover thanks to eco-friendly investments. If this tool was already used in the design stage it would produce a paradigm shift – not immediate and rather complex due to the number of subjects involved and the large amount of information to find and to consider – to change the way of considering materials: from things (products and technologies) to systems (parts linked to each other and to the surrounding environment) conceived throughout their entire life cycle. In addition to the performance, technical and aesthetic characteristics, environmental parameters such as the Embodied Energy and the Embodied Carbon, environmental impacts (for example through EPDs) and the possible effects on public health (for example through the Health Product Declarations) and, obviously, the economic effects (Arroyo et alii, 2012) would support the decision-making stage. Everything would be organized systemically through software that finds valid operational support in the Building Information Modeling (BIM). The challenge is on.

Acknowledgments

The contribution, resulting from a common reflection, is to be attributed in equal parts to both Authors.

Note

1. 1 To overcome the difficulties of applying the Italian Ministerial Decree of 11 October 2017, «in October 2018 the Consiglio dell'Autorità has approved a technical table on CAM in the building sector, to which the MATTM, MIT and many other professional associations participate. During the work carried out so far, the parties involved illustrated the requests and critical issues related to CAMs, including the uneven implementation of the criteria; their compulsory nature, which would result in having further requirements to participate in tenders than those required by the Public Contracts Code; the inclusion of the criteria in the project stage, also to better quantify the basic pricing for tenders and to define the activities required of the companies; the need for a gradual introduction into the tender system and the need to adequately train contracting authorities. It is expected that these critical issues will be analysed by the Authority together with the MATTM, also by virtue of a collaboration agreement on the matter agreed in March 2018, and systematized in a consultation document for the use of guidelines aimed mainly at the contracting authorities on the best use of criteria and on how to balance environmental protection requirements with tender participation requirements, especially for small and medium-sized companies» (ANAC, 2019, p. 36).

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