Environmental parameters for ecodesign: a tool based on ecolabel programs and life cycle thinking

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Abstract: The present study seeks to analyse quantitative and qualitative life cycle parameters of environmental labelling programs in an attempt to verify and demonstrate how these parameters may serve as tools for ecodesign. The aim is to systematise these data and information, in turn facilitating the decisions made in the design process. The study is based on prior works that demonstrate the importance of a life cycle thinking approach in current design tasks as well as the need for targets to achieve environmental goals. The method employed is founded on the analysis of four environmental labelling programs seeking to unveil their potential and similarities in a given product category. The Environmental Parameter for Ecodesign (EPE) is proposed as a tool and discussed in an example of an architectural component. Despite the limitations, it is possible to conclude that the EPE tool has the potential to expand into other product categories.

Keywords: ecodesign tool; product design; life cycle thinking; ecolabel; environmental labelling programs; Type-1 ecolabelling.

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1 Introduction

There is a growing demand for quantified environmental information based on scientific knowledge that is able to serve as a benchmark for the environmental performance of products and services.

On the one hand, environmental labelling (or ecolabel) has been useful in indicating that certain environmental criteria have been taken into account a priori in the design and production of goods and services offered in the marketplace (Cobut et al., 2013). On the other hand, both the quantitative and the qualitative parameters used to analyse environmental criteria can be systematically employed as a tool in the design process, in turn ensuring better environmental decision-making in the product life cycle (Houe and Grabot, 2009), even if obtaining ecolabels is not the true goal of the company.

According to the International Organization for Standardization (ISO, 2000), environmental labels and declarations are one of the environmental management tools which provide information about a product or service in terms of its environmental performance. It seeks to stimulate demand for goods and services with low environmental impact in a given category. Environmental labelling programs (or Type I labelling) are defined by the ISO 14024 standards. These are third party voluntary certification programs that are based on various criteria that consider the product life cycle. Environmental self-declarations (or Type II labelling), are defined by the ISO 14021 standards. These are declarations made by manufacturers, distributors or retailers, without certification by an independent third party. Environmental product declarations (or Type III) are defined by the ISO 14025 standards. These are a type of declaration that supplies quantified data based on the life cycle assessment (LCA) method (ISO 14040) and it is primarily intended for use in business-to-business communication. A program of environmental declaration is conducted by a third party operator and must be based on the product category rule. Interest on the part of companies regarding the presentation of environmental declarations for their products has been growing, spurred on by the expansion of ISO 14025 standards in recent years. This may indicate possible standardisation for comparisons in the near future; nevertheless, Type III and Type II labelling are not applicable to the interests studied in this work.

Since the emergence of ecodesign concepts, life cycle thinking has been intrinsic to the discussions that considered the consecutive and interlinked stages of a product system, from raw material acquisition or the generation of natural resources to the final disposal (ISO, 2002). From the environmental point of view, thinking about the entire product life cycle is essential in the quest to reduce environmental impacts. Likewise, quantified parameters are useful to both compare results and aid in decision-making.

Previous studies have shown that, at the present and ever-increasingly, ecodesign procedures need specific parameters to achieve their environmental targets (Albino et al., 2009; Askham et al., 2012; Chang et al., 2014; Hauschild et al., 2005; Houe and Grabot, 2009; Park et al., 2006; Sanyé-Mengual et al., 2014; Sousa and Wallace, 2006).

Under these circumstances, ecolabel criteria offer a source of quantitative indicators, as well as a qualitative prescription, which can be organised as a tool for ecodesign.

In this light, this study presents an analysis of four environmental labelling programs, including the ABNT-Ecolabel from the Brazilian Association of Technical Standards (*Associação Brasileira de Normas Técnicas – ABNT*), the European Ecolabel (Ecolabel EU), the Eco Mark from the Japan Environment Association (JEA) and the Good Environmental Choice Australia (GECA). All of these associations are members of the Global Ecolabelling Network (GEN), a non-profit association of Type-1 ecolabelling programs (ISO, 1999a). These programs have a common product category linked to furniture and products for building that have allowed for the study of their potential and similarities with regard to an example of an architectural component, *brise-soleil*, made of wood.

Environmental labelling has become a vehicle that companies use to communicate with consumers, but also an economic and trade competitiveness issue. However, environmental labels are not widespread in the furniture and similar industries (Espinoza et al., 2012) despite their environmental importance and the presence of both market and social pressures to adopt ecolabelling. For example, the ABNT-Ecolabel has nine companies certified in the category of furniture products (ABNT, 2014) and the European Ecolabel has two companies (in two countries) in the category wooden furniture (EU, 2014). Moreover, the EU Ecolabel has been heavily criticised for its low market impact. The bureaucracy, complexity, rigidity and costs are some of the reasons given for the low uptake of the ecolabels in the EU (Horne, 2009).

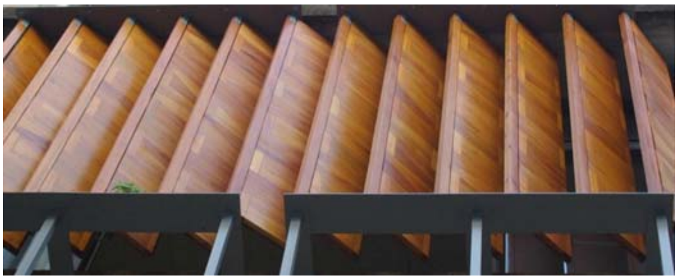
Another possible reason for the low number of companies that participate in label programs might be linked to the interpretation of labelling schemes often requiring expert help (Cobut et al., 2013; Espinoza et al., 2012; Houe and Grabot, 2009), which is an impediment to the participation of small and medium-sized enterprises (SMEs) (Clift, 1993).

Others factors include consumer's satisfaction, values and purchase habits. In general, consumers are poorly informed regarding ecolabels (D'Souza et al., 2006). Furthermore, the increased number of ecolabels resulted in confusion and information overload for consumers (Horne, 2009).

Given these factors and this atmosphere, the Environmental Parameter for Ecodesign (EPE) is proposed as a tool intended to aid designers in their decision-making tasks concerning materials and processes. To date, no studies have been found that correlate these ecolabels in an attempt to verify the use of their criteria as a tool for ecodesign. The EPE is used to collect information from the requirements of the ecolabelling programs analysed and its applicability to design decision-making is discussed based on the *brise-soleil* example.

The *brise-soleil* is an architectural building component used for environmental comfort that allows for thermal control and the entry of sunshine into built environments (Figure 1). *Brise-soleils* are produced by smaller business enterprises, i.e., woodworking and carpentry shops located in the State of Minas Gerais, Brazil. This project aimed to consolidate eucalyptus timber use, bringing benefits in sustainable development terms, among local manufacturers from the Jequitinhonha Valley-MG. It is based on many surveys pointing out that activity related to renewable forests generates ecological, social and economic profits (Pereira, 2013). The companies have the aim of supplying the demands for architectural components, as well as for several wood-based objects, using eucalyptus timber exclusively, adding value to this material, since they are located in a region with large plantings of the specie. Together with environmental arguments, communication must be on the economic aspect (Hauschild et al., 2005), because companies need to see profits in their horizon, preferably in the short term, and especially for SMEs. As a result, patent and industrial design registrations were filed for the product at the Brazilian National Institute for Industrial Property (INPI).

Figure 1 Prototype of *brise-soleil* (see online version for colours)



Thus, this study's analyses lead to a conclusion regarding the potential of the EPE tool to expand its application to other products, materials and processes. However, the limit lies in terms of the availability of ecolabel criteria within a wide range of product categories.

2 Ecodesign approaches and life cycle thinking

Within the ecodesign approach, all stages of the product's life cycle, as well as its production chain, must be considered for the choice of materials, the type of resources applied (renewable or non-renewable) and the types of pollution that will result from production (CEC, 1992; Crul and Diehl, 2006; Hauschild et al., 2005; Quarante, 1994).

This idea began to be known in the early 1970s when the Midwest Research Institute launched its method called the 'Resource and Environmental Profile Analysis' (Hunt et al., 1974), which evaluates a quantitative balance of the flows of matter and energy exchanged with the environment in a production system throughout its life cycle, taking into account raw materials, energy, water consumption, the amount of aqueous and gaseous pollutants, as well as the waste produced during industrialisation processes.

In 2002, the ISO published the ISO/TR 14062, which established recommendations for the integration of environmental aspects into product design. These recommendations can be initiated either *top-down* by management or *bottom-up* by designers who must consider: meeting the environmental standards early in the design process; analysing the product life cycle; thinking about functionality; taking into account the multi-criteria concept, e.g. ensuring that one impact does not lead to an increase in another impact; bearing in mind the possibility of trade-offs among environmental, technical and/or quality aspects, economic and social benefits (tangible, intangible and emotional).

To tackle these environmental goals, some design approaches can be used: improving materials and energy efficiency; reducing land use; creating design for cleaner production and use, for durability, to optimise functionality, for reuse, recovery and recycling; as well as to avoid using potentially hazardous substances and materials in the product.

This standards also indicate actions to be taken related to the integration of environmental aspects in the methodological stages of the product design and development process, including *planning*, *conceptual design*, *detailed design*, *testing/prototype*, *production market launch*, *product review* (ISO, 2002).

According to Lewandowska and Kurczewski (2010, p.770), the *planning stage* is an analysis of "what exists and what should be there, according to the requirements of the interested parties and recommendations formulated in virtue of the reference object analysis", and ecodesign tasks should show target levels and the means through which to achieve them. A relation also exists between *planning* and *design stages*. Ecodesigns depend on the integration of various requirements and needs (from environmental, economic and social aspects); the key issue is to define which variants are the best. The authors suggest applying a multicriteria analysis allowing for comparisons to many quantitative criteria in order to obtain quantitative results, thus leading to the selection of the best variants. At the *detailed design stage* the selected variants should be analysed within the entire life cycle of the product, taking into account the LCA, life cycle cost (LCC) and social life cycle assessment (SLCA).

The assessment of interested parties and environmental, economic and social aspects can be made by using importance coefficient and environmental benchmarking (Lee and Park, 2005; ISO, 2002) for competitive products, according to Kurczewski and Lewandowska (2010).

By contrast, from the managerial point of view, it is important to consider product policies that integrate life cycle thinking in an attempt to improve product performance in all stages of the product's life cycle, including social and economic performance. Life cycle management was proposed in a guide published by UNEP in 2007, which refers to "a product management system aiming to minimize environmental and socioeconomic burdens associated with an organization's product or product portfolio during its entire life cycle and value chain" [Remmen et al., (2007), p.18]. The perspective is to expand the idea to reach principles of sustainability in its *triple bottom line* (people, planet and profit), as well as the "6 RE philosophy" [Remmen et al., (2007), p.13]: RE-think the product and its functions, RE-pair: making the product easy to repair, RE-place harmful substances with safer alternatives, RE-use: considering disassembly, RE-duce: energy, material consumption and socioeconomic impacts; and RE-cycle materials.

ISO (1999b, p.3) also announced the environmental performance evaluation as "an internal management process that uses indicators to provide information comparing an organization's past and present environmental performance with its environmental performance criteria". Therefore, the purpose of an environmental performance evaluation is to search for or develop indicators that can enhance the evaluation in two categories: environmental condition indicators (ECIs) and environmental performance indicators (EPIs) – which can appear in two forms: Management performance indicators and Operational performance indicators.

Remmen et al. (2007) proposed a step-by-step approach to help organisations implement a life cycle management program, and ISO (1999b) provided guidance for environmental management in terms of the plan and use of the environmental performance evaluation. Both approaches are based on a 'plan-do-check-act' management model.

Integrating these ideas in the product policies and in its life cycle implies the inclusion of suppliers and subcontractors, which in turn means broadening the vantage point to internal and external stakeholders within the organisation, consequently expanding the boundaries of the company. Several stakeholders can construct a product system at both a primary level (suppliers/upstream businesses, customers, banks, etc.) and a secondary level (commerce/trade associations, research institutes/universities, media, etc.) (Remmen et al., 2007). The decisions made can influence a number of actors along the life cycles of the products (Hauschild et al., 2005). In this sense, communication, collaboration and information exchange are essential to tracking and managing environmental impacts.

It is important to have reliable management to collect structure and disseminate product-related information to all stakeholders in its value chain. According to Patala et al. (2014), networks are essential in helping companies accomplish the goals of sustainability, such as inter-firm environmental activities (reuse of waste, reduction of energy, etc.), sustainable networks to minimise waste in the supply chain, collaborative coalitions for specific issues, including environmental problems or policies, and collaborative approaches (technologies and/or services) to create eco-efficient solutions. Furthermore, in the scope of the organisation, different departments can contribute to a life cycle management program.

From the viewpoint of product design, indicators are related to operational performance and should be found in the supply of inputs; in the inputs of materials, energy and services; in the outputs of products, services, wastes and emissions; in the delivery of outputs; as well as in the installation, operation and maintenance of the physical facilities and equipment of the organisation (Hauschild et al., 2005; ISO, 2002; Remmen et al., 2007). In addition, LCA can provide quantitative indicators to analyse the environmental impact of a product (Dahlbo et al., 2013; Huulgaard et al., 2013; Sanfélix et al., 2013; Willers and Rodrigues, 2014).

However, despite the LCA, most methods used in ecodesign consider qualitative aspects throughout a product's life cycle (for example, MET Matrix or EcoDesign Strategy Wheel – Brezet and van Hemel, 1997). Also, streamlined LCA methods have been proposed as a life cycle check, and other approaches have been given under the idea of design for environment, e.g., the design for disassembly and the design for recycling (Hauschild et al., 2005).

Initiatives to provide quantitative and qualitative environmental references could help product designers in their tasks (Askham et al., 2012; Chang et al., 2014; Sousa and Wallace, 2006).

It is true that the concept of ecodesign has been changing in recent decades to adopt new ideas that are ever closer to sustainability principles, including the integration of people, planet and profit. However, this does not disregard the reduction in impact on the product's supply chain and throughout its life cycle.

For Bhamra and Lofthouse (2007, p.39), design for sustainability "considers the environmental (for example resource use, end of life impact) and social impact of a product (for example usability, responsible use)".

This can be referred to as a sustainable product design that goes "beyond how to make a 'green' product and embraces how to meet consumer needs in a more sustainable way" [Crul et al., (2009), p.16]. In fact, the idea of sustainability in product design originally emerged in the 1960s through criticisms of modern development launched by authors such as Vance Packard, Victor Papanek, Gui Bonsiepe and Ernst Schumacher concerning consumerism, social responsibility in design, technological precariousness and globalisation (Bhamra and Lofthouse, 2007).

Innovation is necessary for a sustainable product to achieve the *triple bottom line*. For Crul et al. (2009, p.28), innovation can be achieved in the short-term by redesigning existing products (called 'inside-the-box') or in the long-term introduction of radical product innovation (called 'outside-the-box': "developing completely new products, improving products as well as the services connected to them, and developing entirely new functional systems of products and services").

A concept of design for sustainability is proposed in which, in addition to previous procedures adopted by ecodesign, is included an emphasis on the integration of social elements in a radical innovation for sustainability (Haemmerle et al., 2012).

It is possible to observe that for social requirements it is also necessary to have quantified parameters indicating their limits. Social elements can be described as the reduction of urban and minority unemployment, of income inequity, of illiteracy and of population growth; improvements in working conditions, safety, and well-being, and the status of women, incremented in the number of skilled workers, of social opportunities and of community interaction, acceptance and integration of minorities, provisions for basic health services and clean drinking water, abolishment of child labour as well as the large scale dislocation of people, and adopting international employment standards (Crul et al., 2009). Much also remains to be done, such as considering intangible features (Chang et al., 2014).

Crul et al. (2009) present some steps toward design for sustainability, including: select a product, review the product market in terms of environmental and social issues, reflect on the product in light of a simple design for a sustainability list of approaches, develop a quick picture of the product's 'impact profile', define the product's improvement targets and design approaches, redesign concepts, prioritising ideas and concepts.

Joore and Brezet (2014) argue that a multilevel design model should provide insight from design to development of socio-technical and societal level presented in a consistent and comparable manner. Design being a cyclic iterative process based on four phases (reflection, analysis, synthesis and experience) can be conducted at all levels of society, described as system levels: the product-technology system, the product-service system, the socio-technical system and the societal system. The recognition and distinguishing of these levels may help to understand their relationships, the actors involved in the decision process, all elements included in a life cycle, and the different types of problems to be faced.

The evolution of the ecodesign concept and the gain involved with the consideration of social (and societal) elements is indubitable. Nevertheless, it is also undeniable that to reach the triple bottom line is essential, seeking the integration of these aspects as well as the flow analysis of the material, energy and emissions under a life cycle thinking.

An ecodesign checklist is proposed by EIO and CfSD (2013) in an attempt to aid SMEs and business coaches who are in search of eco-innovation. Wimmer et al. (2004) proposed a set of environmental parameters supporting the design team in collecting all relevant environmental information and data for a product life cycle analysis. In addition, the European Parliament established the 2009/125 Directive (EU, 2009a; Huulgaard et al., 2013) as a framework for the setting of ecodesign requirements for energy-related products.

Furthermore, the integration of these aspects into product design and development can be supported by existing management systems (ISO, 2002) such as environmental labelling, which help to provide quantitative and qualitative parameters as targets to product design as the following will demonstrate through the EPE tool.

3 Material and methods

The present study analyses four environmental labelling programs from countries around the world in order to verify their potentials and similarities. The selected programs come from four continents, including the ABNT-Ecolabel from Brazilian Association of Technical Standards, the European Ecolabel (Ecolabel EU), the Eco Mark from the Japan Environment Association (JEA), and the Good Environmental Choice Australia (GECA). These ecolabel programs have been chosen because of their participation as members of the Global Ecolabelling Network (GEN), a non-profit association of Type-1 ecolabelling programs (ISO, 1999a), as well as the fact that they have in existence procedures for a common product category linked to furniture or building products.

Firstly, the ecolabels have been reviewed within their product category. Table 1 presents the product categories for the four ecolabels selected for comparison regarding their similarities.

Table 1 Product category comparison for four ecolabel programs

Ecolabel program	*Product category*
ABNT (Brazil)	*Furniture products:* Chair, wood panel, steel furniture for indoor use, office furniture
	Paper and pulp products: Paper for copy and graphic design services, graphic design production
	Plastics products: Plastic packaging, road marking systems
	Textile products: Textiles for floor covering, textile products for decoration
	Rubber products: Retreated tires
	Steel products: Steel products
	Services: Tourist spots, treatment process of automotive battery electrolyte solution, sustainable events
	Toilets and cosmetic perfumery products: Sunscreen products, instant hand sanitiser, hand sanitisers, personal care products
	Chemical products: Chemicals for concrete
	Other: Thermal and acoustical insulation, data room, telematic cables, products assembled and/or marketed

Note: Eco Mark does not classify product category in groups, each category is done directly in terms of criteria.

Source: Adapted from ABNT (2014), EU (2014), JEA (2014a) and GECA (2014)

Table 1 Product category comparison for four ecolabel programs (continued)

Ecolabel program	*Product category*
EU Ecolabel (Europe)	*Furniture:* Wooden furniture *Paper products:* Converted paper, newsprint paper, printed paper, copying and graphic design paper, tissue paper *Do-it-yourself:* Paints and varnishes *Clothing:* Textile products, footwear *Lubricants:* Lubricants *Electronic equipment:* Imaging equipment, personal computers, notebook computers, televisions *Holiday accommodation:* Campsite services, tourist accommodation services *Coverings:* Wooden floor coverings, hard coverings, textile floor coverings *Gardening:* Growing media* and soil improvers: *materials in which plants can grow (excluding soil) *Household appliances:* Light sources, heat pumps, water-based heaters *Other household items:* Bed mattresses, sanitary tapware, flushing toilets and urinals *Beauty care:* Soaps, shampoos and hair conditioners *Clean-up:* All-purpose cleaners and sanitary cleaners, detergents for dishwashers, industrial and institutional automatic dishwasher detergents, hand dishwashing detergents, laundry detergents, industrial laundry detergents
Eco Mark (Japan)	Furniture, products for civil engineering, Tile-blocks, boards made of wood, products using thinned-out wood, reused wood, building products (materials for interior work), stationery/office supplies, paper for communication, printing paper, sanitary paper, paper packaging materials, plastic products, biodegradable plastic products, paints, toner cartridges, ink cartridges, printing ink, clothes, household textile products, textile products for industrial use, shoes and footwear, leather clothes, gloves and belts, biodegradable lubricating oil, imaging equipment (such as copiers, printers), personal computers, digital duplicators, BD/DVD recorders and players, projectors and television, general insurance (automobile), retail stores, car sharing, hotels and inns, bags and suitcases, water-saving, domestic wastewater, treatment tank, reusable products, refill containers and resource saving containers, returnable containers and packaging materials, glass products, garbage disposer, fire extinguisher, household commodity, watches and clocks, products using photovoltaic cells, solar heating system, vacuum bottles, music instruments, LED bulb lamp, Items for babies and infants, recycled soap made from cooking oil

Note: Eco Mark does not classify product category in groups, each category is done directly in terms of criteria.

Source: Adapted from ABNT (2014), EU (2014), JEA (2014a) and GECA (2014)

Table 1 Product category comparison for four ecolabel programs (continued)

Ecolabel program	*Product category*
GECA (Australia)	*Building and interiors:* Furniture, fittings and foam, panel boards, adhesives, paints and coatings, thermal building insulation materials, textiles and leather
	Stationery (closed to new applicants): Recycled paper products, office paper, printers and printed matter, sanitary paper products
	Plastics and other polymers: Recycled plastic products
	Flooring: Carpets, cleaning services, floor coverings, hard surfacing
	Innovative products (closed to new applicants): Environmentally innovative products
	Personal care: Personal care products
	Cleaning products and services: Cleaning products, machine dishwashing detergents

Note: Eco Mark does not classify product category in groups, each category is done directly in terms of criteria.

Source: Adapted from ABNT (2014), EU (2014), JEA (2014a) and GECA (2014)

The environmental criteria defined by the Type-1 labelling must be established based on a measurable difference in the environmental impact and according to the indicators resulting from considerations based on the life cycle of the product, even if the adoption of the LCA method is deemed unnecessary. The criteria are set according to the product categories and specificities (manufacturers, market, etc.) of each country.

Therefore, secondly, the standards for environmental criteria (Table 2) linked to furniture or building products have been analysed under the four ecolabels:

- ABNT ecolabel: *Ecolabel for Office Furniture: PE-165.03* (ABNT, 2013a) and *Ecolabel for Wood Panel: PE-205.04* (ABNT, 2013b)
- EU ecolabel: *Application Pack for the Ecolabel – Application Form for Wooden Furniture* (EU, 2009b)
- Eco Mark: *Eco Mark Product Category No. 130 – Furniture Version 1.9. Certification Criteria* (JEA, 2014b)
- GECA: *Furniture, Fittings and Foam – GECA 28-2010 v2.1* (GECA, 2013).

Finally, the common and most important data have been compiled in a unified list of criteria based on the controlling standards. This systematisation constitutes a tool (EPE) allowing for the assessment of a product, as well as ensuring better environmental decision-making in its final design.

The four ecolabels studied offer criteria for a common product category, opening the door to a greater understanding of their potential and similarities in light of the example of a *brise-soleil*, a wood-based architectural component.

Table 2 Ecolabels standards and their environmental criteria

Ecolabel program	*Criteria considered*
ABNT (Brazil) Standards: PE-165.03 for Office Furniture and PE-205.04 for Wood Panels	• Adequacy of use proven by laboratories • Raw material: wood derivatives, hazardous substances, formaldehyde content, use of fabric • Manufacture process • Packaging • Final destination • Distribution • Energy and water • Environmental legislation • Labour, anti-discriminatory and safety regulations
EU ecolabel (Europe) Standards: Application Pack for the Ecolabel – Application Form for Wooden Furniture	• Product composition: 90% wood or wood derivative • Hazardous substances • Wood and wood-based materials • Surface finishing • Product assembly, including adhesives • End-of-life: durability, safety, maintenance, recycling and waste, information provided to the consumer, finished product packaging, information on the packaging and information on the label
Eco Mark (Japan) Standards: Eco Mark Product Category 130 – Furniture Version 1.9	• Materials mixture • Prohibition of CFC use • Air pollution, water contamination, noise, offensive odour and emission of hazardous materials • Chemical substance use • Polymers, including halogens and organic halogenides • Coatings • Adhesives • Repair systems • Disassembly • Toluene and xylene use • Material criteria: wood and wooden materials, plastic, fibres, paper, glass, metals • Criteria for individual products: mattress and product for specific procurement • Quality criteria and certification procedure

Source: Adapted from ABNT (2013a, 2013b), EU (2009b), JEA (2014b) and GECA (2013)

Table 2 Ecolabels standards and their environmental criteria (continued)

Ecolabel program	*Criteria considered*
GECA (Australia) Standards: Furniture, Fittings and Foam – GECA 28-2010 v2.1	• Applicable standards and demonstrated fitness • Commercial warranty of quality • Timber and other natural materials • Treatment • Polyurethane and padding requirements • Fabrics • Glass • Adhesives • Emissions: air emissions (formaldehyde and volatile organic compound – VOC) and water emissions • Hazardous materials • Packaging, end of life and product stewardship: replacement parts, separability/design for disassembly, recyclability, coatings/treatments, minimum resource efficient material content, product stewardship, product information and packaging requirements • Public claims • Social and legal compliance: environmental legislation, fair pay, workplace safety, equal opportunity and lawful conduct

Source: Adapted from ABNT (2013a, 2013b), EU (2009b), JEA (2014b) and GECA (2013)

4 Results and discussion

The EPE is proposed as a tool based on the criteria defined by the four environmental labelling programs discussed above.

The EPE tool does not seek to allow designers to meet the criteria of ecolabels *per se*, it seeks to allow that the criteria used in ecolabels, which have been analysed and recognised in many countries as relevant for environmental improvements, can be used as ecodesign requirements – even if the goal is not to acquire an ecolabel. For this, it is necessary that these criteria are organised in a more reasonable way for designers.

The EPE presents a systematic description of possible parameters supported by life cycle product thinking, including the items shown in Table 3: product description and the raw materials employed, use of hazardous substances, surface finish, product assembly, and end-of-life strategies.

The product analysed in this study was the *brise-soleil*, as mentioned above. It consists of only one module (the fins), and it can be attached to the facades of buildings in varying lengths in an upright position. Its application is flexible, since it is performed by setting a number of modules side by side at equal intervals. The number of fins is determined by the desired visual effect and the range of the window. This allows the manual movement of the fins, whether separately or together. Many fins can be attached to a steel mechanism to move together. The fins can be locked into six different positions through a steel part fixed to the base, according to the desired opening angle.

Table 3 Environmental parameter for ecodesign applicable for wood-based product category

	Parameter 1: materials	*Reference*
1.1	Wood employed must be from sustainable forest management.	Forest Stewardship Council (FSC) certification or similar
1.2	Use of waste, wood chips or wood fibres in the production of wood-based materials according to the limit of chemical contamination.	European Panel Federation (EPF, 2014)
1.3	Product must not be treated with chemical impregnating and conservatives and the wood must not be treated with hazardous products.	Use of hazardous substances. Parameter 2
1.4	Wood panels must not contain hazardous products.	Use of hazardous substances. Parameter 2
1.5	Formaldehyde emissions must be controlled and ranked as class E1: Panels uncoated or coated on one side: ≤ 8 mg/100 g Panels coated on both sides: ≤ 3.5 mg/m^2.h	European standards: EN 120 (perforator method) EN 717-2 (gas analysis method)
1.6	Product may not contain genetically modified wood.	European Union Directive 2001/18/EC EU (2009b) GECA (2013)
	Parameter 2: Hazardous substances	*Reference*
2.1	Product may not contain hazardous substances, at risk (R-phrases): R23, R24, R25, R26, R27, R28, R39, R40, R42, R43, R45, R46, R48, R49, R50, R51, R52, R53, R60, R61, R62, R63, R68	R-phrases: European Union Directive 67/548/EEC and Directive 1999/45/EC
2.2	The product is allowed to use flame retarders that are only chemically linked to the material or on the surface (reactive retarders), but they may not contain R-phrases: R40, R45, R46, R49, R50, R51, R52, R53, R60, R61, R62, R63, R68	Presentation of Material Safety Data Sheets (MSDS)
	Parameter 3: Surface finish	*Reference*
3.1	Surface treatment with plastics or metals may not exceed 2% of the product weight.	EU (2009b)
3.2	Other treatments limited to 5% of the VOC; the quantity of substances that are toxic to the environment (painting and varnish) must be limited to 14 g/m^2 of the covered surface and 35 g/m for VOCs.	European Union Directive 1999/13/EC and Directive 1999/45/EC
3.3	The formaldehyde emissions must be limited to 0.05 ppm	EU (2009b)
3.4	If there are plasticisers, the phthalates must respect the rules of hazardous products; din-octylphthalate (DNOP), diisononyl phthalate (DINP), and diisodecylphthalate (DIDP) may not be used.	EU (2009b)
3.5	Biocides must be used with restrictions. The product should not be treated or impregnated with fungicides and insecticides that are classified by their hazardous nature by IARC as type 1 or 2 and WHO pesticides 1a and 1b.	International Agency for Research on Cancer – IARC World Health Organization – WHO

Table 3 Environmental parameter for ecodesign applicable for wood-based product category (continued)

Parameter 4: Product assembly	*Reference*
4.1 Adhesives and glues must not contain hazardous products.	Item 4.2
4.2 The VOC content of adhesives and glues must not surpass 5% (w/w).	EU (2009b)
Parameter 5: End-of-life	*Reference*
5.1 The maintenance of the product must be able to be done without the use of organic solvents; the manufacturer must guarantee the availability of replacement parts during the entire manufacturing period.	ABNT (2013a, 2013b) EU (2009b) JEA (2014b) GECA (2013)
5.2 The product must be easily recyclable; for this, information must be provided to consumers about product disassembly and final disposal.	
5.3 Information must be provided to consumers about the relevant environmental aspects: name and origin of the wood species; surface finishing and product maintenance; incentive for the prolonged use of the product; recommendations for the replacement and disposal of the parts, such as the glass; recommendation on the recycling and final disposal of the product.	
5.4 The packaging of the final product must be made of a recyclable material, from renewable sources and/or sources that can be reused (ex. textiles), and must be easily disassembled, in monomaterial, to facilitate recycling.	

In addition to the usability and aesthetics principles, the *brise-soleil* was also designed under environmental and sustainable requirements. It has been designed to be manufactured from renewable raw materials, solely eucalyptus grown in planted forests, and utilising concepts such as commercial modularisation, ease of installation, use and maintenance, as well as increasing value of identity patterns.

The assessment provided by the EPE tool has allowed additions to those concepts of sustainability other qualitative and quantitative requirements. Firstly, it was important to search for certified wood and not wood treated with chemical impregnating and conservatives. Also, it was important to confirm that a hybrid wood is not a genetically modified wood. As the product is produced using solid wood, some requirements have been not considered, e.g., the hazardous substances that can be employed for the manufacture of plywood, particleboard, MDF, etc. On the other hand, the varnish, sealer and glue have been chosen in light of the limits required for the surface finish and product assembly criteria. Likewise, concerns about product end-of-life have been introduced in that, organic solvents for maintenance are not used, parts are easily replaced, disassembly is easy, and all environmental relevant information is provided for the consumers.

Finally, all of the specifications designed have been compared with the EPE parameter applicable to the wood-based product category (Table 3), as seen in Table 4.

Table 4 Application of the EPE in the design of a *brise-soleil*

	Parameter 1: Materials
1.1	The *brise-soleil* has been designed to be made up of at least 93.3% Eucalyptus wood from a forest certified by Cerflor (according to the ABNT/NBR 14790:20 14 standard – Sustainable forest management – Chain of Custody – Requirements).
1.2 *1.3* *1.4* *1.5*	The *brise-soleil* has been designed to use solid wood not treated of *Eucalyptus urograndis*, a hybrid of the *E. grandis* and *E. urophyla* species.
1.6	The hybrid *E. urograndis* is done by a natural process (pollination, grafting, cuttings, etc.) to obtain a final product that is more appropriate for use. This process does not generate a genetically modified wood.
	Parameter 2: Hazardous substances
2.1 *2.2*	The materials specified to the *brise-soleil* not contain hazardous substances.
	Parameter 3: Surface finish
3.1 *3.2* *3.3* *3.4* *3.5*	The surface treatment and finishing of the *brise-soleil* are performed with water-based acrylic sealer and acrylic varnish (Aquaris YL 2140 and Aquaris YO30 1453 by Syerlack) – not contain VOC. The applied varnish and sealer do not contain hazardous substances in prohibited R-phrases, as is shown in the MSDS. It not contains plastics or metals, formaldehyde emissions, plasticisers, biocides, fungicides or insecticides.
	Parameter 4: Product assembly
4.1 *4.2*	An adhesive (Casco-Rez® 2500 TN of Hexion), composed of polyvinyl acetate dispersed in water, is used for the assembly process – not contain VOC.
	Parameter 5: End-of-life
5.1	The maintenance of the product is done without the use of organic solvents and the product is easily recyclable, because it is made in a minimal variety of easily separable materials.
5.2 *5.3*	All information is provided to consumers about wood origin and certification, surface finishing and product maintenance.
5.4	Packaging of the final product is not previewed, because this process is performed by the producer.

The product category proposed in this study is found in the furniture or building products criteria for the existing environmental labelling standards, and can also be applied to other wood-based products, such as flooring, wall coatings, doors and window frames, stairwells, etc. Likewise, the method can be expanded into other product categories according the standards for each product category.

The EPE tool can contribute to the process of lessening the environmental impact of manufacturing by disseminating information about businesses' environmental practices, especially for microenterprises and small businesses.

5 Conclusions

The present study demonstrated that environmental labelling can be a source of quantitative and qualitative environmental parameters to be employed as a tool in the design process.

However, the complexity presented by ecolabel procedures can be difficult to interpret, thus requiring the help of experts, and hindering the use of its criteria in design tasks, especially by microenterprises and small businesses.

Prior studies have shown the importance of a life cycle thinking approach and the need for targets to reach environmental goals in the product design process.

The EPE tool sought to both facilitate and optimise the use of ecolabel criteria and parameters as references for product design, even if obtaining ecolabels is not the core aim of a company.

The application of the example of a *brise-soleil* shows that the data systematised in the EPE tool can help design teams by providing environmental parameters and targets to be met in product design, ensuring better environmental decision-making in the product life cycle.

The EPE tool collects data from several ecolabel programs, but the established limit is linked to the availability of criteria in a larger diversity, especially as regards the product category.

Despite its limitations, it is possible to conclude that the EPE tool presents the potential to expand into other existing product categories.

The next step, which is already underway, seeks to develop a platform for collecting data to broaden environmental labelling programs. This appears to be possible for product categories, materials and processes, in an attempt to make the product parameters and targets more accessible, especially to microenterprises and small businesses.

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