Journal of Cleaner Production xxx (2015) 1–10

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Environmental responsibility in building design: an Italian regional study

Eleonora Annunziata, Francesco Testa*, Fabio Iraldo, Marco Frey

Sant'Anna School of Advanced Studies – Institute of Management, Piazza Martiri della Libertà 33, 56127 Pisa, Italy

ARTICLE INFO

Article history:
Received 25 February 2013
Received in revised form
5 February 2015
Accepted 27 July 2015
Available online xxx

Keywords:
Eco-design
Designers
Building and construction sector

ABSTRACT

The building and construction sector plays a crucial role in implementing energy efficiency and, more generally, in reducing environmental impacts. In this context, design is a key-phase for effective improvement in the whole sector. Therefore, the adoption of the Eco-design approach can be a "green" turning point for the strategies of this sector. This study aims to investigate factors and drawbacks that drive designers in the implementation of Eco-design. The data are collected by a questionnaire survey covering a considerable number of designers in Tuscany (region in Central Italy). The results reveal that designers have a high environmental sensitivity, but a systematic adoption of Eco-design approach is still far. Moreover, the study highlights the spreading in the sector of those "internal" key factors that normally foster the inclusion of energy and environmental criteria in the building design, e.g. training, cooperation with supply chain and certification schemes.

1. Introduction

The building and construction sector (B&C sector) is a major contributor to the growth of many economic systems and can play a crucial role in implementing improvements towards energy efficiency and, more in general, in reducing the most relevant environmental impacts in order to prompt to sustainable development patterns and to favour the transition to a low-carbon economy. Looking at the available data, it is easy to understand that the European Union (EU) B&C sector substantially affects two crucial pillars of sustainability. On the one hand, it accounts for 37.1% of total final energy consumption (European Union, 2010), and 35% of the greenhouse emissions (European Commission, 2007). On the other hand, the B&C sector in the EU represents approximately 10% of GDP and is the largest industrial employer with 14.8 million employees and 3.1 million enterprises in 2007 (Schultmann et al., 2010).

The economic and environmental relevance of this sector is demonstrated by the intense and cross-sectional EU regulatory action which affects energy used in buildings for heating, cooling and lighting, environmental impacts related to building materials and even wastes produced at the end of life (e.g. Energy Performance of Buildings Directive, Energy Efficiency Directive, Ecodesign Directive, Energy Labelling Directive). In this context, the adoption of an Eco-design approach can strongly decrease the environmental impacts throughout different life cycle stages (Karlsson and Luttropp, 2006) and in particular improve environmental and energy performance during the "use phase" of a building. Moreover, an Eco-design approach can contribute to reduce the environmental footprint mainly associated with the phase of implementation and construction of a building (Solís-Guzmán et al., 2013), because it can tackle environmental issues shown by the environmental footprint, namely the amount of land that is necessary to provide the resources and absorb the emissions (CO_2) of humanity (Wackernagel and Rees, 1996; WWF, 2008).

Several studies have investigated economic and non economic benefits of Eco-design approach (O'Rafferty, 2008; Plouffe et al., 2011; WGBC, 2013), success factors for its integration in product development process (Ehrenfeld and Lenox, 1997; Ritzén, 2000; Johansson, 2002) and related barriers (Vakili-Ardebili and Boussabaine, 2005; Luttropp and Lagerstedt, 2006); research has developed and analysed several tools to implement Eco-design approach in general (Rio et al., 2013; Peuportier et al., 2013) and in the design phase of buildings (Sobotka and Rolak, 2009; Crosbie et al., 2010; Nemry et al., 2010). In recent years, designers have been covering a major role in determining the environment-oriented

* Corresponding author. Tel.: +39 050 88 31 11; fax: +39 050 88 32 25.
E-mail address: francesco.testa@sssup.it (F. Testa).

http://dx.doi.org/10.1016/j.jclepro.2015.07.137
0959-6526/

strategies of the B&C sector and in supporting policies for sustainable buildings. Many studies investigated their perception of sustainability as a proxy for the whole industry (Chong et al., 2009), their market estimations and forecasts for green buildings (Chan et al., 2009), and the impact of energy efficiency and energy saving policies on building design activities (Adeyeye et al., 2007). However, there is a scarce knowledge about diffusion of the Eco-design approach in the building design process and related the role of designers.

In order to contribute to fill this gap, this paper aims to understand if and to what extent Eco-design is already embodied in the current building design process and what factors influence its adoption from a designers' perspective by way of a statistical descriptive analysis. This analysis used data collected by a questionnaire survey among designers located in a specific region (Tuscany) of Italy that well reflects the dynamics and characteristics of the B&C sector at national level – negative economic trend, in term of job losses, failed companies and credit crunch, persisting along the last 5–7 years and a productive backbone made of small of very small firms (ANCE, 2014). Because Italy is one of EU countries with the larger building stock (Raya et al., 2011) and has an annual rate of new constructions corresponding to European average (Meijer et al., 2009), the focus on Italy was considered also suitable for analysing the capabilities of European countries towards achieving EU targets for sustainable buildings. The findings of this study also provide insights into the Italian B&C sector field, so far characterized by a chronic lack of data (Albino and Berardi, 2012).

This paper is structured as follows: Section 2 presents a literature review about concept of Eco-design, its supporting factors and barriers. Section 3 describes variables and methodology. Section 4 refers to the results of empirical data analysis. Section 5 presents a discussion and conclusions providing policy implications and some directions for future research.

2. Literature review

2.1. The concept of Eco-design

By the beginning of 21st century the growing environmental issues associated with industrial production and consumption fosters the need for a new product design approach, i.e. Eco-design, as expression of a world-wide sustainability. The concept of Eco-design is defined as the integration of design aspects and environmental concerns in the development of product and services (Karlsson and Luttropp, 2006) in order to decrease environmental impacts throughout different life cycle stages, without compromising other product and service criteria such as performance and cost (Johansson, 2002). Therefore, the Eco-design approach aims to determine the environmental impact associated with the whole life-cycle and to consider environmental factors during the design of products, processes and activities (Sun et al., 2003; Pujari, 2006).

The Eco-design approach can be adopted to achieve "incremental" green products and services in order to reduce one or two specific environmental problems (e.g. low CFC refrigerators to limit ozone depletion), or "systematic" Eco-design (e.g. compact fluorescent lamps) that tackles all environmental impacts throughout the product life cycle from initial manufacture to final disposal (Roy, 1994). Generally, the Eco-design approach can be applied to all categories of products and services characterized by different levels of complexity, i.e. the presence of numerous sub-systems and alternative technical solutions, interdependence among sub-systems, different modes of operating, and interaction with external environment (Tchertchian et al., 2013). Therefore, Eco-design can be applied to complex systems such as "urban design" processes, where the life cycle of a city consists of all the stages through which it evolves, including the architectural design and construction stage (Farreny et al., 2010), and buildings which can be considered as "material products of competing social practices" (Guy, 2006). In particular, the adoption of Eco-design in the B&C sector refers to a structure and use processes which are environmentally responsible and resource-efficient throughout a building's life-cycle by considering the following aspects: design, materials, equipment, energy generation and services. These aspects are described in detail in Table 1.

2.2. Strategic supporting factors for Eco-design

Several studies have identified a number of factors for the successful integration of Eco-design in product development (Roy, 1994; Handfield et al., 2001; Johansson, 2002; Lindahl, 2003; Boks, 2006) which can be associated to the implementation of Eco-design in the B&C sector.

One of most frequently mentioned factor is management commitment and support which refers to aspects such as the establishment of clear environmental goals, not only for organizations, but also for individual product development projects (Ehrenfeld and Lenox, 1997; Ritzén, 2000). This implies that environmental considerations should be balanced against commercial aspects by considering not only the operational dimension of Eco-design but also strategic dimension (Ehrenfeld and Lenox, 1997; Ritzén, 2000). This finding suggests that the adoption of Eco-design in the B&C sector is certainly influenced by the environmental "sensitivity" of designers, and by their ability to catch the opportunities connected to energy efficiency improvements and reduction in environmental impacts of buildings and of the related materials (Chong et al., 2009) balancing them with financial and time-effectiveness criteria (Lovins, 1992).

Another essential factor is the collaboration with supply chain because the suppliers are an important source of information about environmental alternatives in materials, components and processes (Johansson, 2002). This factor is much more crucial in sectors characterized by a complex supply chain such as the B&C sector (WBCSD, 2008). The B&C sector is composed by several key actors having competing and different interests (Hakkinen and Belloni, 2011). In particular, the demand pressures on designers and trades is relevant and also influences all the actors of the supply chain (e.g. service and material suppliers) (Lönngren et al., 2010; Mentzer et al., 2001). Literature on supply chain management in the B&C sector, since the 1990s, has emphasized the importance of engaging and co-operating with the actors that operate upstream and downstream (Segerstedt and Olofsson, 2010). Some studies suggested a more integrated supply chain among contractors, suppliers and clients (Dubois and Gadde, 2002) and argued that there is a tight relation between supply chain management and market structure (Cox and Townsend, 1998) and the complexity of building projects (Humphrey et al., 2003; Love et al., 2004). Other studies highlighted the key-role of communications between different actors of the supply chain during the design process (Dong, 2005; Hassan, 1996). A possible solution to communication barriers is the partnering which improves social collaboration in the design process and, consequently, the quality of the design outcomes (Xie et al., 2010). Elaborating on these findings of the relevant literature, one can argue that an effective interaction among actors of supply chain can be a factor that favours the adoption of an innovative approach as the Eco-design.

Since the individuals should be encouraged to take an active role in the integration of the Eco-design approach in the product development process, their education and training become an important means to realize operative Eco-design approach (Ritzén,

Please cite this article in press as: Annunziata, E., et al., Environmental responsibility in building design: an Italian regional study, Journal of Cleaner Production (2015), http://dx.doi.org/10.1016/j.jclepro.2015.07.137