Analysis of the impacts of economic and social indicators to sustainability assessment

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ABSTRACT: Literature review shows that there is no standard method to assess buildings' sustainability neither to identify which items/indicators should be assess. Literature also reveals that early phases of a building project are essential to assure the buildings' sustainability. As so, a research project has been established aiming at improving early design stages of a building project by providing concepts and methods for increasing the whole life-cycle sustainability performance. Therefore, in a first phase it is essential to analyse which is the impact of taking into account sustainable indicators during the initial phases of a building, and which should be the chosen ones. Hence, the paper proposes a methodology to analyse the impact of considering social and economic indicators in a sustainable building construction and its assessment.

1 INTRODUCTION

The concept of sustainability is widespread since 1987 with the publication of the Bruntland Report "*Our Common Future*". Since that, several definitions and implications to the concept have been made (Forsberg and von Malmborg, 2004, Weytjens, 2009). Nowadays, it is accepted that sustainable development is supported by three pillars: environment, society and economics. Since construction plays an important role in the world's economy and society has a strong environmental impact, it seems obvious to link it with the sustainable development concept (Burgan and Sansom, 2006, Ding, 2008). Thus, all dimensions should be considered by all construction stakeholders during its entire life cycle and also should go hand in hand as part of the construction framework evolution (Ilomaki et al., 2008, Mateus et al., 2008).

Accordingly to the United Nations, more than 50% of the world's population live in urban areas (UN, 2010) and 80% to 90% of time is passed inside buildings (Direcção-Geral da Saúde - Ministério da Saúde Português, 2010). Therefore, it is critical to embed the building sector in the sustainability concept.

In the nineties, industrial sectors, including the building sector, started to recognise that their activity has a great impact on the environment. Since then, a shift in how buildings are design, built and operated was preformed, in order to mitigate the environmental impacts (Crawley and Aho, 1999). For this to happen, there were two main driving forces, public policy, which increasingly became more conscious and tighter in what regards environmental issues, and the growing market demand for environmentally friendly products. Public policies have been settled down to meet the objectives outlined by the *Rio de Janeiro Conference,* in 1992. However, according to (Ugwu et al., 2005) this conversion into real practice remains a difficult task. Science and research in sustainability represent an important contribution to facilitate this step. With this in mind, a lot of methodologies and tools have been developed since 1990, year in which the first sustainability assessment tool was published (Haapio and Viitaniemi, 2008). Nowadays, it is possible to count more than 70 tools for evaluating and classifying buildings according to sustainability indicators. Nevertheless, most of them are mainly focused on

environmental protection and there is a lack of participation of all the stakeholders involved in the building life cycle (Ugwu et al., 2005, Saparauskas, 2007, Braganca et al., 2010).

Taking into account the high number of existing tools and methodologies, which have inherent problems and variables, the International Organisation for standardisation (ISO) is attempting to achieve harmonisation in sustainability building assessment and in environmental construction products declarations. A summary of the ISO standards in this regard, developed until now has been made e. g. by Fernández-Sánchez (2010). Also the European Committee for Standardisation (CEN) and CEN/TC "Sustainability of construction work" have been developing voluntary horizontal standardised methods for the assessment of the sustainability aspects of new and existing construction works and standards for the environmental product declaration (EPD) of construction products (Haapio and Viitaniemi, 2008, FOLVIK and WAERP, 2009).

Many authors support that early design phases of a building are the most crucial for the sustainability performance of the building (Weytjens, 2009, Thompson and Bank, 2010). In building design various aspects are analysed, compared and compromised. Selecting final solutions among alternative systems and products requires good understanding of the owner's and end users' needs. Moreover, performance requirements and sustainability aspects need to be considered. All these issues influence the building's life-cycle sustainability performance.

Consequently, and considering the constant evolution on the building sector towards a sustainable built environment there is a need to establish and develop a design support tool to integrate, deal with and to ensure the sustainability of buildings. As so, this paper shows the first steps to achieve the mentioned goal. It is aimed to analyse the influence of the social and economic indicators on the execution of a building project and construction.

2 OBJECTIVES AND SCOPE

As it was previously referred there is a need to develop and implement a systemic methodology, which supports the design process and is capable of gathering, in a simple and easy understandable way, all the information needed to build up a sustainable new building. At the moment there is no norm or standard to indentify indicators and measure a building's sustainability, following a technical-scientific model, existing however some proposals. It is now defended by many authors that the best way to improve a building's sustainability is to consider all the sustainable dimensions right at the early design phases of the building project. In order to be sustainable, a building must obey the following aspects: respect for the environment, social integration and social economy, maintaining cost, time, quality and performance within an acceptable range (Braganca, 2010).

With this in mind, this paper represents a part of what is being developed to achieve an early stage design support tool. A first and important task of the research is to analyse the design process of buildings in order to identity how the process is organized, to know which are and how the sustainability performance requirements are defined and how these requirements influence the buildings' sustainability assessment, being this latter aspect the aim of the paper.

3 METHODOLOGY

3.1 *Background*

The basis of the presented research is to, in a first stage, identify and establish a set of economic and social indicators, through literature review and by inquiring the buildings' stakeholders. In a second phase, is to survey and interview designers, suppliers, users and clients and by following up on developers processes.

The literature review showed several studies concerning the sustainability indicators' identification. Fernández-Sánchez (2010) proposed a methodology, based on the identification of sustainability indicators by considering sustainability as opportunities for the project and on the establishment of indicators for measuring and controlling these opportunities. For that, they used risk management standard methods (PRAM and PMBoK) and the framework of ISO 21929-1. The identification phase was performed through literature review, survey to

stakeholders, comparison between answers, analysis of check-lists and diagramming techniques. The authors reach a set of 30 indicators and verified that the best technique to understand accurately the differences between all stakeholders, allowing a better identification of indicators, is the stakeholders' survey.

Ugwu *et al*, had published several papers over the key performance indicators (KPIs) identification aim (Ugwu et al., 2006a, Ugwu et al., 2006b, Ugwu and Haupt, 2007). In (Ugwu et al., 2006a) they propose an analytical decision model and a structured methodology for sustainability appraisal in infrastructure projects – SUSAIP. Specifically for the KPIs identification they propose a framework based on a primary literature and governmental guidelines review and case-study data collection, a stakeholders questionnaire to identify the core sustainable indices and a survey to senior stakeholders to test, select and map the indicators to national sustainability goals. This proposed methodology was used by them in the other mentioned papers. From the different case-studies preformed it was possible to identify the existence of a vast set of indicators, including not just environmental, economic and social indicators, but also health and safety, resource utilization, and project administration.

Alwear and Clements-Croome in (Alwaer and Clements-Croome, 2010) presented a conceptual model for the selection of KPIs for intelligent buildings. They propose a three-step model that, like in previous studies. The first step is to identify the main KPIs based on literature review and on a pre-survey to selected stakeholders; the second is to refine and test the selected KPIs by testing the level of importance of the selected indicators and the third step is the development of a sustainability assessment model – SuBETool).

Huovila and Rozado in (Huovila and Rozado, 2010) show an approach towards value metrics from the point of view of end users of facilities. They start from a life cycle performance measurement against related costs and carbon footprint. Those indicators are then bridged with owner's sustainable businesses, happiness of changing users of the facility and citizens' quality of life. First, they used CREDIT (Construction and Real Estate - Development of Indicators for Transparency) project (Porkka et al., 2010), which has developed an indicator framework focusing on issues that are relevant for the users in the operation phase of buildings, trying to link that with metrics, which can be used in real estate business by owners, and also with the user experience. On the other hand, they applied also the Perfection (Performance Indicators for Health, Comfort and Safety of the Indoor Environment) project (Huovila et al., 2010, Desmyter and Huovila, 2010) which aims at developing a framework for indoor performance indicators and mapping them to sustainability.

In what regards cost indicators, Stoy *et al.* in (Stoy et al., 2008) intended to develop a methodology to considerably reduce the prediction error during the cost estimation in early design and propose positive drivers for the success of construction projects. To achieve these goals the author started with a literature review to identify the potential cost drivers and their relation with the building construction costs. The collected drivers were than exposed to a group of specialist in order to selected and determine the main ones. After that, an empirical study was performed on 75 residential properties. A regression model was used to exam the correlation between the construction costs and several cost drivers. The study allowed the identification of the following cost drivers: Compactness of the building, number of elevators, absolute size of the project, construction duration, proportion of opening in external wall and region.

3.2 *Indicators identification*

In order to achieve the goal, the followed methodology is divided into 3 phases, as the reviewed literature proposes:

- Critical selection factors and indicators;
- Survey to stakeholders;
- Results analysis.

The first phase consists in choosing the most appropriate criteria to formulate the set of indicators. As so, as primary approach a literature review was preformed, like it is stated in background section and a second step consists in surveying the main stakeholders as: architect, engineers, suppliers and clients (Alwaer and Clements-Croome, 2010), in order to determine which would be the most relevant social and economic indicators to interfere in the sustainability of a building and its assessment.

By the literature review it is proposed to put under analysis the set of indicators presented in Table 1. To select these indicators, besides using the publications mentioned in the previous

section, there were also taken into account the indicators from (World Steel Association, 2010, BRE Global Ltd, 2009, iiSBE Portugal, 2010).

Table 1. Proposed Social and Economic Indicators.

Social Indicators	Economic Indicators
Culture	Costs
Cultural heritage	Direct Costs
Built heritage	Indirect Costs
Respect customs and beauty of the place	Life Cycle costs (investment, initial cost, maintenance costs, demolition costs
Accessibility	Local economy
Public access (transports and amenities)	Bureaucracy
Biodiversity access	Types of contracts
Safety and Health	Synergies with actors
Safety and health for workers	Product warranties
Impact on global community	Installations and set
Security of infrastructures	Project management
Safety and durability	
Usability	
Thermal quality	
Acoustic quality	
Indoor air quality	
Lighting conditions	
Ventilation conditions	
Materials toxicity	
Aesthetics quality of building and indoor spaces	
Functionality	

The list shown in Table 1 should be presented to the stakeholders, for them to identify the main indicators based on their influence on the whole life cycle of a building. Nevertheless, they should be invited to attach new attributes to the proposed indicators and new ones, according to their experience and knowledge.

3.3 *Survey*

After selecting the main indicators a second and deeper survey is needed. This survey aims at finding the impacts of considering social and economic issues during the early phases of a building's life cycle. Therefore, there is a need to select few running projects of several actors in the building project, as following up a building design in a design office and following up the construction of materials and technologies needed for the building construction. This is an important phase of the research project, as it allows the understanding about the knowledge of the actors on these issues, their concerns, doubts and fears when applying them. The gained know-how enables to reduce the barriers of up taking sustainability principles. This is possible since it allows improving the methods of considering these issues, giving also an excellent basis for the work that needs to be done in order to achieve the support design tool and its acceptance by the stakeholders. In order to have a better view over the actual reality, the survey should be performed to different types of building solutions, as steel-framed and reinforced concrete, and in different locals, as different regions in a country or even in different countries analysis.

In this way, the parameters analyse during the survey for each set of indictors is shown in Table 2. This task might need a long period of time to be executed, as so, it is essential to design a cohesive and coherent data management system and that reliable data is collected. However, this back-office work is not under analysis in this paper.

Table 2. Proposed parameters and stakeholders under survey.

Stakeholders	Parameters
Architect	Expectations
Engineer	Difficulties
Construction Materials Supplier	Advantages
Project Manager/Coordinator	Personal opinion
Client	How the issues are deal with
	Main constrains
	Importance of each item

3.4 *Results analysis*

The analysis of the gathered data is a decisive and extremely important process of this methodology. As proven in background sections, there is not only one method of analysing the collected data. So, it is proposed to be used statistic methods as well as sensitive and multi-criteria analysis methods, (Alwaer and Clements-Croome, 2010, Balcomb and Curtner, 2000). These methods must be applied to help on an empirical assessment, allowing reducing errors and subjectivity on the results. It is important to rank all the aspects given as answer to the parameters and determine their final impact in the building sustainability.

The results should allow identifying the weaknesses and strengths of all stakeholders when considering social and economic issues.

4 CONCLUSION AND FURTHER RESEARCH

As stated in the introduction there is no standard methodology to assess and guarantee the sustainability of a building. With this in mind a research project is being carried out to develop a support design tool aiming at improving the buildings' sustainability in early design phases. This paper presents the first step of the research, the development of a method for identifying the impacts of social and economic indicators on a sustainable building construction and assessment. It is of high importance to understand how these issues are dealt with, during the early phases of a building, and how they interfere in the final assessment.

The proposed methodology constitutes a first approach towards the development of the aimed tool and allows a true knowledge on how design process is conducted and which are the barriers of up taking sustainability principles.

It is important to state that the methodology needs further research. It is mandatory to develop and deepen the results analysis by applying the methodology to case-studies.

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