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A methodology to identify sustainability indicators in construction project management—Application to infrastructure projects in Spain

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ABSTRACT

Since the birth of the sustainable development concept and its application to urban planning and construction projects, countless sustainability indicator sets have appeared. This paper analyses the problems posed by these sets and the need to establish a method to identify and select an indicator set which includes every participant involved in the life cycle of a project, to find a proper balance between all actors. Sustainability is proposed as an opportunity for improvement throughout the project. Thus, we have developed a methodology to identify, classify and prioritise sustainability indicators based on risk management standards. The application of this method to infrastructure projects in Spain will reveal the strengths and weaknesses of the proposed method and is the first step to develop an indicator set for civil engineering projects.

1. Introduction

The introduction of sustainable development both in urban planning and construction projects is a fact. With the appearance of Agenda 21 at the 1992 Earth Summit, the need to apply sustainability to cities at a strategic level arose. In 1994 the concept of sustainable construction was born at a tactical level in the building sector and in civil engineering. New targets for projects were added to the common triple objectives: cost, time and quality. Therefore, it is necessary to develop new techniques and tools that will allow environmental, social and economic commitments to be met (Fernández-Solís, 2006; Rodríguez López and Fernández Sánchez, 2008).

At present, more than 6400 municipalities worldwide are involved in the Agenda 21 process (ICLEI, 2002). This means that, as the Agenda 21 document itself outlines, there is a need to construct an indicator set that allows sustainable targets to be met in urban development, as well as to control and monitor the progress of these indicators over time. Each institution has adopted different indicator systems with the following results: a great disparity of dimensions and indicators without the existence of a global consensus to select them (Wilson et al., 2007); that everyone involved in the process of selecting indicators participates, which happened in only half of the municipalities registered world-wide (ICLEI, 2002); the high degree of arbitrariness revealed by the indicators (Singh et al., 2009); the great differences in the number of indicators (Button, 2002; GTIS, 2004); and the relative importance of the environmental area compared to social and economic areas (GTIS, 2004). The aforementioned problem arises in spite of international efforts during the 1990s to establish models for generating indicators such as the Organisation for Economic Cooperation and Development (OECD)'s Pressure-State-Response (PSR) Model for the development of environmental indicators; which subsequently developed to sustainability indicators in the United Nations Department for the Policy Coordination and Sustainable Development's Driving Forces-State-Response (DSR) system and the Driving Forces-Press-State-Impact-Response (DPSIR) model of the European Environment Agency, Eurostat and the OECD.

Furthermore, there are nowadays more than 70 tools for evaluating and classifying building projects in the building sector, based on sustainability indicator systems (Fernández Sánchez, 2008). These indicators also present considerable problems such as: uncertainty and subjectivity when selecting criteria, indicators and dimensions (Hueting and Reijnders, 2004; Seo et al., 2004); the predomination of environmental aspects when evaluating the sustainability of buildings (Saparauskas, 2007); the lack of participation of all the stakeholders involved in the project life cycle (Fernández Sánchez, 2008); and the number of indicators that generally should be small and in the existing systems of indicators is very high (Alarcón Núñez, 2005). In this sector, the International Organization for Standardization (ISO) is attempting to achieve homogenisation in the application of sustainability. A framework is established for the development of indicators (Table 1) but not a methodology for creating and selecting them.

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Table 1
ISO standards in relation to sustainable aspects in building and their indicators.

Standard	Standard title	Year published
ISO 21929-1	Sustainability in building construction—sustainability indicators. Part 1: framework for development of indicators for buildings	3-2006
ISO 21930	Sustainability in building construction—environmental declaration of building products	10-2007
ISO 21931-1	Sustainability in building construction—framework for methods of assessment for environmental performance of construction works. Part 1: buildings	6-2008
ISO 21932	Sustainability in building construction—terminology	2005
ISO 15392	Sustainability in building construction—general principles	5-2008
CEN EN 15643-1	Sustainability of construction works—integrated assessment of building performance. Part 1: general framework	Draft
CEN EN 15643-2	Sustainability of construction works—integrated assessment of building performance. Part 2: framework for the assessment of environmental performance	Draft
CEN EN 15643-3	Sustainability of construction works—integrated assessment of building performance. Part 3: framework for the assessment of social performance	Draft
CEN EN 15643-4	Sustainability of construction works—integrated assessment of building performance. Part 4: framework for the assessment of economic performance	Draft

At the same time, two research projects aim to create a standard for the indicator systems to evaluate sustainability in the building sector. One of them is the LEnSE research project (sixth research programme of the EU) which is now complete. The other, the universal seal of sustainable buildings supported by the World Council of Civil Engineers (WCCE) is currently in their final phases of development. The latter aims to solve the problems posed by the diversity of indicator systems co-existing in the building sector.

Finally, the term *'sustainable construction'* has been centred almost exclusively on buildings, but gradually, sustainability targets are being introduced into civil engineering projects as well. Thus, indicator sets have cropped up for bridges and viaducts such as the SUSAIP model (SUStainability Appraisal in Infrastructure Projects) formed by criteria identified through interviews and surveys performed on the different participants in the project life cycle (Ugwu et al., 2006). Also, the TSI (Technical Sustainability Index) proposed by Dasgupta and Tam (2005) where the indicators have been created on the basis of existing scientific documentation.

Consequently, and keeping in mind that the construction sector is evolving towards an increase and a development of the number and type of social, economic and environmental indicators (Zhang et al., 2008), there is the need to establish a methodology for the identification of sustainability indicators from the project management point of view.

2. Objectives and scope

As mentioned in the introduction, there is a huge demand for methodologies that identify indicators related to urban planning and construction projects (building and civil engineering). At the moment there is no norm or standard model of identification that follows a technical-scientific methodology, although there are some proposals (as Bell and Morse, 2008). We believe that a project is sustainable when the project improves in all three sustainable development dimensions, i.e. environmental respect, social integration and social economy, maintaining cost, time, quality and performance, at an acceptable range.

For these reasons, we propose to establish a methodological process to identify and select sustainability indicators by considering them as opportunities (positive risks) of the project and to achieve a balance between the impacts that occur during the project life cycle, as well as to obtain social, economic and environmental benefits. The main objective is, therefore, to propose a methodology for selecting indicators, which will be developed by all stakeholders, thus reducing the subjectivity and uncertainties of the process. The identification of every project opportunity is sought, to advance towards sustainability.

Primarily, the scope of this work is the identification, selection and prioritisation process where the greatest problems happen, since there is a great development of individual indicators with a high scientific reliability.

3. Methodology

3.1. Background

The basis of the proposed methodology is to identify sustainability indicators by considering sustainability as opportunities for the project and to establish indicators for measuring and controlling these opportunities. By proposing to treat sustainability as an opportunity, we can identify the different sustainability factors of a project by applying risk management standards, as Hillson (2002) suggested in connection with the suitability of applying risk management to project opportunities.

The current standards for risk management have been studied (Table 2), for their possible application in identifying opportunities and sustainability indicators and, consequently, to create an appropriated methodology based on project management with the techniques used in risk identification, but adapted to the sustainable goal.

From an analysis of the different standards found about sustainability in the construction industry and standards for risk management, we tried to evaluate the possible viability of applying the existing risk management techniques to the identification of sustainability indicators. Thus, following the diagram in Fig. 1, the ISO-21929-1 standard has been selected as the indicator framework. Although it is just based on building indicators, it grants us a first approach by taking a standard pattern. Consideration has been given to the PRAM standard and the risk management included in PMBoK guide, among others, to identify and select sustainability indicators. These standards are closer to the treatment and identification of opportunities in construction projects, while other standards are more related to strategic risk management for business, groups and organizations. Based on and supported by these standards we can proceed to define the methodology.

The ISO-21929 Standard establishes boundaries and defines what is meant by a sustainability indicator:

> "*Indicators are figures or other measures, which enable information on a complex phenomenon like environmental impact to be simplified into a form that is relatively easy to use and understand. The three main functions of indicators are quantification, simplification and communication" (ISO-21929, 2006, p. 6)*

In the methodology proposed here, the ISO standard provides the framework to follow when identifying and selecting indicators