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Methodology for the development of a new Sustainable Infrastructure Rating System for Developing Countries (SIRSDEC)

Jose Manuel Diaz-Sarachaga, Daniel Jato-Espino, Daniel Castro-Fresno*

GITECO Research Group, Universidad de Cantabria, Avd. de los Castros s/n, 39005 Santander, Spain

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ABSTRACT

The improvement of infrastructures in developing countries has become a priority for the most advanced economies, which have founded a broad range of international development organizations to undertake infrastructure projects worldwide. Infrastructure is the key driver that can accelerate the balance among the economic, social and environmental aspects forming the Triple Bottom Line (TBL) in these countries. Given the lack of appropriate tools to ensure the achievement of this goal, this paper describes the methodology conceived for the development of a Sustainable Infrastructure Rating System (SIRSDEC) aimed at promoting the design, construction and operation of sustainable infrastructure projects in these geographical areas. SIRSDEC is structured into a hierarchical decision-making tree consisting of three levels of elements (requirements, criteria and indicators) selected to assess infrastructure systems according to sustainability principles. The methodology on which SIRSDEC is based combines the action of two multi-criteria decision-making methods (MCDM) such as the Analytical Hierarchy Process (AHP) and the Integrated Value Model for Sustainable Assessment (MIVES). AHP is proposed to weight the elements forming the decision-making tree after processing the opinions provided by a group of international experts regarding the importance of requirements, criteria and indicators, whilst MIVES is suggested to value infrastructure projects according to their contribution to the TBL. The article emphasizes the added value provided by the combination of AHP and MIVES in the design of an ad-hoc rating system aimed at fostering the implementation of sustainable infrastructure projects in developing countries.

1. Introduction

The third of the 27 principles proclaimed in the final Declaration of Rio + 20 United Nations Conference on Sustainable Development held in June 2012 stated that the right to development must be fulfilled to meet developmental and environmental needs of present and future generations. This principle reaffirmed the key role of sustainability in contemporary society and promoted the urgent need for developing effective frameworks to balance long-term economic, environmental and social aspects in construction processes (UN, 1992a).

A sustainability rating system can be defined as a set of best practices that evaluates sustainability through the scoring of a series of indicators (Hart, 2006). Furthermore, this framework enables diverse indicators measured in different units (e.g. pollutants/carbon emitted to atmosphere, renewable energy used, recycled materials, energy consumption/conservation, ecosystem/biodiversity preservation, culture heritage maintenance, etc.) to be integrated into a single analysis aimed at rating infrastructure projects in terms of their contribution to sustainability.

Property industry was the pioneer in the development of sustainability rating systems for buildings in advanced economies, such as Leadership in Energy and Environmental Design (LEED) in the U.S. (USGBC, 2009), Building Research Establish Environmental Assessment Method (BREEAM) in the U.K. (BRE, 2014) and Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) in Japan (IBEC, 2011). A few years later, the transportation community designed its own specific systems too. At present, there are a significant number of national and international rating systems oriented to evaluate green buildings and only a few focused on analysing infrastructures from the point of view of sustainable development. These systems vary in terms of scope and complexity but are generally designed to provide guidance, scoring and potential rewards for using sustainable best practices. Rating systems usually focus on practices that are

* Corresponding author.
E-mail addresses: jose-manuel.diazs@alumnos.unican.es (J.M. Diaz-Sarachaga), jatod@unican.es (D. Jato-Espino), castrod@unican.es (D. Castro-Fresno).

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compatible with current regulations but are beyond existing minimum regulatory requirements. The main purpose of most sustainability rating systems is not to set a scientifically defensible taxonomy of sustainability, but rather a tool to encourage the implementation of sustainability practices beyond regulatory minimum targets and communicate sustainability concepts in a comprehensible manner to all stakeholders, from construction professionals to citizens.

Rating systems are often criticized because they tend to minimize the appraisal of economic and social aspects in detriment of environmental issues (Gibberd, 2005). In addition, international development agencies and organizations have not broadly incorporated rating systems into the assessment of their project processes (UNOPS, 2012), whilst the evaluation of the economic benefits derived from their implementation is very complicated (FIDIC, 2012). In relation to the context of this research, rating systems are also deficient due to their focus on developed economies and omission of specific features of third world countries (EAP and ARUP, 2011a).

There are three main rating systems that assess infrastructure projects following the principles of sustainability: ENVISION (USA) (ISI, 2012), Civil Engineering Environmental Quality (CEEQUAL) (BRE Group, 2015) and Infrastructure Sustainability (IS) Rating Tool (Australia) (ISCA, 2012). A review of these rating systems revealed that they are imbalanced in relation to the importance given to the three pillars of sustainability, also known as the Triple Bottom Line (TBL), since the number of environmental credits considered are more numerous than those assigned to economic and social aspects (Diaz-Sarachaga et al., 2016). Commercial reasons are the main goal of infrastructures rating systems in richer nations, in order to advertise the quality of projects and the interest of clients, designers and/or builders in sustainability, whereas the context of developing countries requires a different approach for evaluating the whole sustainability contribution of projects to the development of these nations. The lack of data related to the indicators included in existing frameworks and the disregard for management practices are another setbacks which hinder the accurate implementation of these tools in developing countries.

Moreover, these systems were found to be mainly oriented to their countries of origin and omit most of both the Millennium Development Goals (MDGs) established in the United Nations (UN) Millennium Declaration (UN, 2000) and the Sustainable Development Goals (SDGs) adopted by the UN General Assembly on 25 September 2015 (UN, 2015). MDG 1 (Eradicate Extreme Poverty & Hunger), MDG 3 (Promote Gender Equality and Empower Women) and MDG 7 (Ensure Environmental Sustainability) should be included in rating systems for infrastructure projects in developing countries. SDGs 4, 5, 11 and 16 address social issues such as the search for education equality in terms of gender and quality, the transformation of cities and human settlements in safe, inclusive and resilient places. The promotion of sustainable economic growth and employment and resilient infrastructure and industrialization are targeted by SDGs 8 and 9. The governance area, which corresponds to SDGs 12 and 17, involves the use of sustainable consumption and production patterns and the strengthening of the global partnership for sustainable development.

The scarcity of definitive management guidelines to establish key elements for assessing the degree of sustainability of a project confuses owners, consultants and other stakeholders. The implementation of sustainability management practices and reporting systems is also crucial to meet project goals for sustainable development and measure progress towards the achievement of these aims (FIDIC, 2012).

As a contribution to enhance the field of sustainable rating systems, this paper proposes a methodology and a set of TBL indicators to create a new Sustainable Infrastructure Rating System for Developing Countries (SIRSDEC) through the combination of two multi-criteria decision-making methods: Analytic Hierarchical Process (AHP) and Integrated Value Model for Sustainable Assessment (MIVES). The combination of AHP and MIVES has been used successfully in the past to appraise the contribution to sustainability provided by different construction alternatives (San-Jose Lombera and Garrucho Aprea, 2010; Pons and Aguado, 2012), to the extent of being included in the Spanish Structural Concrete Standard (EHE-08) (Aguado et al., 2012). AHP is used to weight the elements into which the system is structured according to the opinions returned by a group of international experts regarding their relative importance, whilst MIVES provides value functions to transform indicators measured in different units into a value index (Jato-Espino et al., 2014). SIRSDEC arises as an effective response to the weaknesses detected in current infrastructure rating systems and seeks to create, develop and implement a tool capable of guiding and promoting sustainable development in poorer countries through the implementation of infrastructure projects.

2. Sustainable infrastructure in developing countries

The United Nations (UN) created the Human Development Index (HDI), based on the consideration of a series of criteria such as life expectancy, per capita income and literacy rate, to classify countries into categories according to their economic development. Countries with an HDI below 0.8 are generally considered as Developing Countries. UN has 193 member states, of which 53 and 140 are classified as developed and developing countries, respectively. Developing countries include Albania, Bosnia and Herzegovina, Serbia and Macedonia in Europe, Africa, Asia (except Japan, South Korea, Hong Kong, Singapore, Qatar, Brunei and Bahrein) and South America (excluding Chile and Argentine) (UN-Habitat, 2015).

Developing countries require a major increase in infrastructure investment to reduce growth constraints, contribute to urbanization needs and meet their development, inclusion and environmental goals. Global trade plays an outstanding role in countries development and consequently in infrastructure. This includes traditional transport infrastructure such as roads, railways and ports, and information technology infrastructure. World population is expected to increase from 6.1 to 8.1 billion between 2010 and 2030 (UN-Habitat, 2011). Most of this rise corresponds to urban settlements located in developing countries, which accelerates more the need of sustainable urban infrastructure (UN-DESA, 2014).

Infrastructure role is also essential to ensure the sustainability of economies through the limitation of environmental impacts of infrastructure assets, mitigation of Climate Change and fostering of sustainable practices (Ebobisse, 2015). The rise of investment budget has been estimated from $1 trillion per year nowadays to approximately $1.8–2.3 trillion per year by 2020, assuming 4% of Gross Domestic Product (GDP) annual growth rate, which means about 3–8% of total GDP (Fardoust et al., 2010). In addition, $200–300 billion are destined for measures aimed at ensuring lower emissions and more resilience to climate change. Fig. 1 depicts pie charts indicating the investment required in 2020 according to regions and sectors. East Asia Pacific (EAP) is expected to require most of this investment, followed by South Asia (SA) and Latin America and The Caribbean (LAC). Regarding the distribution by sectors, basic infrastructure such as Electricity, Water and Transportation monopolize most of the budget. An estimate of 1.4 billion people still has no access to electricity, whilst 0.9 billion do not have access to drinkable water and 2.6 billion lack basic sanitation, which justify the importance of focusing on the first two sectors (Bhattacharya et al., 2012).