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Evaluation of existing sustainable infrastructure rating systems for their application in developing countries

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ABSTRACT

Several sustainable building rating systems were created worldwide during the last decades due to economic growth and the significance of environmental impact associated with the building industry. Similar infrastructure rating tools have started to be developed and implemented, being highly necessary to promote its development. Even though the existing sustainable infrastructure rating systems are focused on advanced economies, growing environmental concerns are increasing the need for new systems in the Developing World. This research analyses some of the mainstream infrastructure rating frameworks such as Envision (USA), Civil Engineering Environmental Quality (CEEQUAL) assessment (UK) and Infrastructure Sustainability (IS) Rating Tool (Australia) from the perspective of the Triple Bottom Line (economy, environment and society), in order to determine the effectiveness of their application in the context of the least developed countries. The analysis revealed that the three tools are biased towards the environmental dimension and are mainly oriented to developed countries. Consequently, the foundations on which these systems are based need to be further developed and enhanced to be of real relevance in poorer nations by balancing the weight of sustainable pillars, incorporating effective management guidelines and development goals set by United Nations declarations, and considering impacts beyond the single project framework.

1. Introduction

The Brundtland Commission Report defined Sustainable Development in 1987 as "development to meet the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Sustainability is based on the balance of three key aspects named the Triple Bottom Line (TBL) (Elkington, 1997): Economics, Environment and Social responsibility. Economics seeks to fulfil the main goal of producing a long-term and positive economic impact, whilst Environment encourages organisations to benefit the planet as much as possible through sustainable practices, including the consideration of negative factors to the environment. Social responsibility aims to improve the lives of those with whom the projects interact. The well-being of users, workers, community members and other stakeholder interests should be considered as interdependent variables in Sustainability assessments (Pope et al., 2004). As a consequence of the rising energy consumption and greenhouse gas emissions in the last century, which accounts for 30 and 40% of the total quantities for the building sector in developed countries (IPCC, 2007), climate change has accelerated the development of international declarations and policies to preserve the environment and foster the use of assessment systems aimed at improving Sustainability.

Sustainability assessments have been defined as the processes of identifying, predicting and evaluating the potential impact of different initiatives and alternatives on the Triple Bottom Line (economy, environment and society) (Devuyst, 2000). Furthermore, rating systems provide an effective framework for assessing environmental performance and integrating sustainable development into building and construction processes. They can be used as design tools by setting sustainable design priorities and goals, developing appropriate sustainable design strategies and determining performance measures to guide sustainable designs and decision making-processes (Ando et al., 2005; Cole, 2003). Amongst them, rating tools for buildings emerged more than two decades ago (Häkkinen, 2007) in the UK and US before spreading worldwide.

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The most relevant are LEED (Leadership in Energy and Environmental Design) in the US (LEED, 2016), CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) in Japan (CASBEE, 2016) and BREEAM (Building Research Establishment Environmental Assessment Method) in the UK (BREEAM, 2016). The building industry boosted the utilisation of these systems primarily for commercial buildings in the US due to the greater quantity of resources required in relation to the whole sector: 72% of electricity consumption, 39% of energy use, 38% of carbon dioxide (CO_2) emissions (EIA, 2008), 40% of raw materials use, 30% of waste output and 14% of potable water consumption.

On the other hand, the use of assessment tools focused on major infrastructures has not been very common so far. Several score ratings have been developed by various public and private institutions to assess highways and roads, but only three of them (Envision in the USA (Envision, 2016), CEEQUAL in the UK (CEEQUAL, 2016) and the Infrastructure Sustainability (IS) Rating scheme in Australia (IS, 2016)) are able to evaluate all types and sizes of civil infrastructures, including ports, airports, highways, dams, bridges, wastewater treatment facilities, tunnels and railways.

This research aims to compare and assess existing sustainable infrastructure rating tools to determine whether any of them can be effectively implemented in developing countries. The effect of urban development is examined under the perspective of its impact in the social and economic transformation of countries. Although green community frameworks are widely used to monitor the sustainable development of cities, infrastructure systems can provide a complementary tool to promote the balanced consideration of all TBL principles. Since most megacities are located in the least developed world, the implementation of infrastructure rating systems in these countries is a key factor to improve their sustainable development over the next decades. The article continues with a description and comparison of the three main existing infrastructure rating systems in terms of their compliance with sustainability, in order to identify the differences between developed and developing countries that need to be considered for their application in poorer economies. As a result, some principles and goals emanating from several United Nations Declarations, which seek to mobilize efforts through sustainable development worldwide, are suggested for incorporation into sustainable infrastructure frameworks.

2. The effect of urban development on sustainability assessment systems

The world is predominantly urban. 10% of the world's population inhabited urban areas at the beginning of the 20th century. By 2012, 50% of the global population lived in urban areas, a percentage which is expected to rise to 70 per cent by 2050 (United Nations, 2008). Today, 3.6 billion urban dwellers are distributed unevenly among urban settlements of different sizes and more than 7 of every 10 urban residents in the world are found in developing countries. The level of urbanisation is expected to increase in all major areas of the developing world over the coming decades, with Africa and Asia urbanising more rapidly than the remaining continents (UNEP, 2006). The importance of urban areas is also confirmed by the diffusion of megacities of more than 20 million people, which are gaining ground mostly in the developing countries of Asia, Latin America and Africa (Berardi, 2015). Consequently, urbanisation will become a prominent trend over the next decades that should be meticulously considered in the assessment of sustainable development, in particular for poorer economies.

Urbanisation has the power to transform the social and economic fabric of countries. Cities are responsible for the biggest production and consumption of resources worldwide and are the main driver of economic growth and development, with about three-quarters of global economic activity coming from urban settlements. Urban population growth stimulates the urban share of global gross domestic product (GDP) and investment. The opportunity for development in countries can only be approached through sustainable urbanisation (SDSN, 2013), which emphasises the economic and social importance of urban areas and also their poor environmental sustainability.

Urban projects promote the development of urban infrastructure through the encompassment of a very broad group of activities related to urban planning, urban design and architecture, transport studies, economics, ecology, geography, sociology, water management and engineering, waste management, energy engineering and economics, landscape planning and building architecture. Urban policy design is one of the most challenging problems for decision-makers because rapid urbanisation has increased the need for better governance of towns and cities. There are a number of different policy areas that need attention, including planning, housing and slum upgrading, land, energy and climate change, reconstruction and resilience, as well as infrastructure (transportation, water and sanitation), all of which should be added to the complexity of modern-day policy decision-making (UN Habitat, 2007).

Sustainable urban development has become a powerful framework for developing solutions that improve the quality of life at a local level and can also be an important component to respond to the broader global environmental crises (UNCTAD, 2014). Urban planners have taken up the challenge of designing urban areas across the globe in ways that leave a smaller ecological footprint. Cultural values, education and citizen and community participation are all crucial aspects to consider when defining, measuring or implementing sustainable urban development policies and practices.

The difficulties in assessing sustainability in the urban environment are greater because of the lack of boundaries between the entities evaluated. Sustainability assessments at community and city scales are much more than the summation of individual green elements, because the scaling-up effect results in complex interactions that significantly alter the results obtained at building scale (Haapio, 2012). New frameworks for communities have been developed within the past years as an evolution of the sustainable building rating systems mentioned in the previous section in order to avoid the building scale factor. The most well-known systems are BREEAM Communities (Com) (BREEAM Communities, 2009), CASBEE for Urban Development (UD) (CASBEE for Urban Development, 2007) and LEED for Neighbourhood Development (ND) (LEED for Neighbourhood Development, 2009).

BREEAM Com consists of forty individual assessment issues spanning five technical categories, plus a sixth category called "Innovation" for new and innovative technologies and practices. Each issue addresses a specific large-scale sustainability impact and is grouped within one of the five main technical categories: governance, land use and ecology, resources and energy, social and economic wellbeing and, transport and movement. Governance ensures the community involvement and leadership in the project, whilst land use and ecology improve biodiversity. The reduction of carbon emissions and use of natural resources is targeted by the resources and energy category, whereas healthy economy, socially cohesive community and the minimisation of impact on the health and wellbeing of inhabitants are goals sought by the social and economic wellbeing categories. Finally, the transport and movement category aims to create a safe and efficient transportation system for people and vehicles.

CASBEE UD considers two main kinds of criteria: performance and environmental loads. Performance criteria include factors such as the natural environment, quality of services and the contribution to the local community, whereas the environmental loads cover