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Investigating sustainability parameters of administrative buildings in Saudi Arabia

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ABSTRACT

Cultural differences have always been considered a crucial factor in the implementation of ready-made models. Following international interest, Arabian communities have promoted the need to adopt sustainability strategies in construction, with the vital goal of minimizing environmental impacts and overcoming resource limitations. This paper presents a generic framework for selecting the key sustainability parameters for office and administrative buildings in Saudi Arabia because these types of buildings consume huge amounts of resources and generate a massive amount of waste and carbon dioxide emissions. The framework building blocks start with benchmarking regional and international rating systems. Next, a swift review of regional literature and emerging concepts is performed. The results are then tabulated to establish a pool of criteria. For this effort, a total of 112 criteria have been identified and grouped into five main groups. The next step involves industry engagement, which is best investigated through a questionnaire. The final step is the survey results analysis using two techniques: severity index (SI) and exploratory factor analysis. The resulting factors are considered to be key parameters when constructing a new rating system that considers cultural differences.

1. Introduction

It is a well-known fact that a community's social and cultural practices impact its surroundings, environment, and people. The implementation of new policies or strategies may face resistance for many reasons related to cultural awareness. Sustainability is one of many illustrious terminologies in the construction industry over the last decade, but has the greatest potential to effect change (Steele et al., 2002). Sustainability improves social, economic and environmental conditions for present and future generations, and enhances quality of life to allow people to live in a healthy environment (Ortiz et al., 2008). The construction sector has a huge impact on the environment through aspects such as waste production, high energy consumption, external and internal pollution, CO_2 emissions, environmental damage and consumption of non-renewable resources (CICA, 2002; Melchert, 2005; Zimmermann et al., 2005; Majdalani et al., 2006; Bakhoum and Brown, 2012). More specifically, the building sector in the United States alone is responsible for 40% of the national energy consumption, 39% of carbon emissions, 30% of waste output, 72% of electricity consumption, and 13% of water consumption (USGBC, 2009, 2012). The massive growth of the construction sector increases its negative impact on the environment each year. For example, greenhouse gas emissions from buildings will more than double in the next 20 years if nothing is done (SBCI, 2009). The increasing construction impacts on the environment and resource limitations enhance the importance of adopting more sustainable lifestyles (Ljungberg, 2007). To counter the continuous increase in negative construction impacts on the environment, it is necessary to develop sustainability measures that ensure the development of sustainable and green buildings (Abdallah et al., 2013). The extreme environmental conditions in Saudi Arabia increase the need to adopt sustainability measures in many fields, including the construction field. Despite the limitations of natural water resources in the Kingdom of Saudi Arabia, the Kingdom is one of the biggest water consumers worldwide. The Saudi government earmarked about $53 billion for various water projects to be completed by 2022, and also earmarked about $79.9 billion for energy projects over the next decade (The Economic Times News, 2013). Administrative and office buildings represent a significant portion of the Saudi construction industry. Developing sustainable administrative buildings helps to reduce water and energy consumption and also reduces the construction industry's negative impact on the environment.

This paper aims to provide a generic framework for selecting key sustainability parameters for offices and administrative buildings that suit the extreme environmental conditions in Saudi Arabia while taking into consideration the major influence of cultural practices in Arab communities. These key parameters can also be used to evaluate the sustainability of administrative buildings and to reduce the environmental

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impact resulting from these buildings. Additionally, the key parameters identified through this study will be used as a base for developing a holistic rating system to estimate the sustainability score for different design alternatives, to achieve more sustainable designs with cultural practices as a cornerstone. The rating system can also be used for existing buildings, to identify the necessary change(s) that can be applied to achieve a more sustainable score.

2. Proposed framework

The framework building blocks start with the benchmarking of regional and international rating systems. This is followed by a literature review of regional emerging concepts; findings are then manipulated to form a pool of parameters. The next step involved industry engagement, and a final step includes results analysis and discussion of recommendations. The framework methodology schematic diagram shown in Fig. 1.

Benchmarking of regional and international rating systems was conducted to highlight and identify an initial list of sustainability parameters; this serves as a generic list to evaluate the sustainability of administrative buildings in any given location. Further, through the review of emerging regional concepts, parameters that may be of specific interest to the Saudi Arabia community were identified. Through data manipulation, a pool of parameters was constructed and findings were clustered into groups. Moreover, as an efficient method of industry engagement, a comprehensive survey was prepared using the pool of parameters and then distributed to local experts, academia and practitioners. The task is considered essential to ensure the practicality of parameters with respect to sustainability in administrative buildings in the Kingdom of Saudi Arabia. The questionnaire consisted of three main sections; the first section covered respondent and company general information such as name, organization type, major, and years of experience. The second section investigated the main groups of parameters. The respondents were asked to rate the appropriateness of the groups on a five-point priority scale ranging from 1 (completely inappropriate) to 5 (completely appropriate). The third section included the whole list of pooled and grouped parameters. Again, the respondents were asked to identify the appropriateness score for each parameter, using the same five-point priority scale previously introduced. At the end of each group of criteria, the respondents were given the chance to add and rate any additional parameters. Additionally, an online version of the questionnaire was designed to overcome time and face-to-face survey difficulties. The results analysis phase is carried out to examine questionnaire results using two techniques: simple severity index (SI) and exploratory factor analysis. The first technique identified the factors of highest score and impact and assessed those most influencing factors. The second technique produced a more in-depth analysis, and used exploratory factor analysis based on the collected data set, with a focus on principal components analysis.

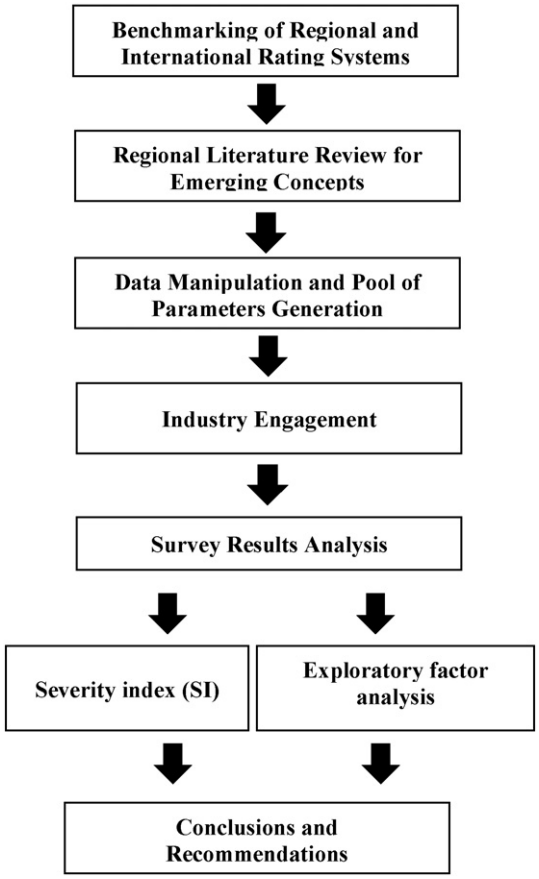

Fig. 1. Methodology schematic diagram.

3. The pool of parameters

There are more than 600 rating systems worldwide for evaluating sustainability in the construction industry (BRE, 2008). The rating systems evaluate the sustainability of buildings by awarding points for satisfying green building criteria or parameters. The sustainability parameters and their importance weights usually differ from one system to another according to differences in environmental and regional conditions and also due to cultural differences. Accordingly, each region needs to identify sustainability parameters that fit its conditions. The sustainability rating systems that were considered in this study included LEED, BREEAM, and Green Globes as examples from international rating systems. GPRS and Pearl were selected as the regional examples. The aim of selecting such diverse regional and international rating systems is to reflect a wide range of environmental conditions.

Leadership in Energy and Environmental Design (LEED®) is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across all important metrics: energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts (LEED-NC, 2009). The BREEAM rating system became one of the most comprehensive and widely recognized measures of a building's environmental performance. It sets the standard for best practices in sustainable building design, construction and operation. BREEAM encourages designers, clients and others to think about minimizing energy demands, low carbon and low impact design, health and wellbeing, pollution, water efficiency and many other perspectives (BREEAM Offices, 2008). Green Globes is an online green building rating system that is used primarily in Canada and the USA. It is a revolutionary assessment tool for building environmental design and operation and management. The assessment criteria in this system are classified into seven groups: management, pollution, site, water, energy, material and indoor air quality (Green Globes, 2004). The Green Pyramid Rating System (GPRS) is a Green Building Rating System that was developed by the Egyptian Green Building Council. GPRS evaluates building sustainability performance in seven key areas: sustainable site, energy, water, materials, indoor air quality, management, and innovation (GPRS, 2011). The Pearl Rating System aims to address the sustainability of construction throughout its lifecycle, from design through construction to operation. The Pearl rating system is organized into seven categories that are fundamental to more sustainable construction: integrated development process, natural systems, liveable buildings, precious water, resourceful energy, stewarding materials, and innovating practice (Pearl, 2010). Table 1 provides a comparison of the key sustainability groups/categories included in the main rating systems that have been considered in this