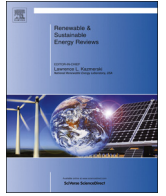




Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Sustainable material selection for construction industry – A hybrid multi criteria decision making approach

Kannan Govindan ^{a,*}, K. Madan Shankar ^b, Devika Kannan ^c^a Department of Business and Economics, University of Southern Denmark, Odense 5230, Denmark^b Department of Mechanical Engineering, PTR College of Engineering and Technology, Madurai 625008, India^c Department of Technology and Innovation, University of Southern Denmark, Odense, Denmark

ARTICLE INFO

Keywords:

Sustainable construction
Sustainable indicator
Sustainable material selection
Hybrid MCDM
UAE

ABSTRACT

Urbanization and globalization has led to a rapid development in the construction industry. Many strategies have been proposed to improve cost effectiveness in this sector. Over the last decade, cost concerns have been balanced with a growing debate on the necessity for sustainable construction practices. Because of depleting resources and environmental concerns, researchers and practitioners have begun to explore sustainable construction strategies. Among these strategies is the selection of sustainable materials which play a vital role in a building's environmental footprint. In the UAE in particular, there is an ongoing demand to select the best sustainable construction materials because the industry is growing so rapidly in this nation. Thus, the main intent of this paper is to propose a model to evaluate the best sustainable construction material based on sustainable indicators through a hybrid multi criteria decision making (MCDM) methodology with a specific examination of the UAE. The indicators collected from existing literatures were used in evaluation of sustainable construction materials with the assistance of construction sector-based respondents. The proposed framework was validated with a case study company, and the results were compared to the existing literatures and to feedback from the respondents. Finally, the study concludes with an assessment of its own limitations along with the identification of some useful managerial implications; it sheds some light on future possible enhancements in the theme of sustainable construction in the context of UAE.

© 2015 Elsevier Ltd. All rights reserved.

Contents

1.	Background and theory	2
1.1.	Framework of the study – execution flowchart:	3
2.	Solution methodology	3
2.1.	Phase I: DANP	3
2.1.1.	Step 1: calculate the initial relationship matrix 'A'	3
2.1.2.	Step 2: calculate the normalized direct relationship matrix 'X'	4
2.1.3.	Step 3: calculate the total influence matrix 'T'	4
2.1.4.	Step 4: calculate the sum of rows and columns.	5
2.1.5.	Step 5: set up causal influence diagram.	5
2.1.6.	Step 6: calculate an unweighted supermatrix 'W'	5
2.1.7.	Step 7: calculate the weighted supermatrix.	5
2.1.8.	Step 8: limit the weighted supermatrix	5
2.2.	Phase II: TOPSIS	6
2.2.1.	Step 1: constructing the decision matrix	6
2.2.2.	Step 2: construct the normalized decision matrix.	6
2.2.3.	Step 3: construct the weighted normalized decision matrix.	6
2.2.4.	Step 4: determine the positive-ideal and negative-ideal solutions	6

* Corresponding author.

E-mail address: gov@sam.sdu.dk (K. Govindan).

2.2.5.	Step 5: calculate the distance of each alternative from A^* and A^-	6
2.2.6.	Step 6: calculate the closeness coefficient [64]	6
2.2.7.	Step 7: rank determination	6
3.	Application of proposed framework	6
3.1.	Step 1: data collection	9
3.2.	Step 2: analysis of sustainable indicator using DANP	9
3.3.	Step 3: evaluating the best sustainable material using TOPSIS	11
4.	Results and discussions	11
5.	Managerial implications	13
6.	Conclusions	14
	References	14

1. Background and theory

Rapid urbanization and an increase in the urban population amplifies the rate of infrastructure development all around the world, making the construction industry one of the fastest developing sectors throughout the global arena, particularly in the gulf nations. During the last decade, the gulf region, through these development of oil sectors, experienced a tremendous shift in economic and social transformation, with the result being that the United Arab Emirates (UAE) and Qatar are now considered the worst environmental polluters [1,2]. Correspondingly, the UAE holds the world's top position with its ecological footprint [2,3]. Modern buildings may use up to six times the energy of older, more traditional buildings in UAE [4]. In light of this concern, the UAE and many other countries have started numerous initiatives to build eco-friendly buildings, which not only address economic concerns but also utilizes sustainable construction, passive architecture, building energy efficiency, renewable energy integration and other factors into the construction sector [5–11]. There are many strategies for sustainable buildings, but sustainable construction garners more positive reviews from critics due to its impact on both environment and society and the economy. Hence, the construction companies are striving hard to implement and adapt sustainable practices into their construction and to initiate various strategies such as sustainable designs, structures, and material selection. This breadth of approaches results in various research topics in the literature. The history of the introduction of sustainable construction remains unclear, but the first literature definition of sustainable construction was proposed in the first international conference on sustainable construction in 1994 in Tampa by Charles Kibert. According to Kibert, "Sustainable construction is the creation and responsible management of a healthy built environment based on resource efficient and ecological principles" [12–14]. When sustainability became a prominent factor in construction, various researchers sought to analyse sustainable construction through different lenses, including geographically-based sustainable construction [13,15–18], reporting in sustainable construction [7,19–26], reviews of environmental initiatives, and various other sustainable closed concepts within the construction sector [27–34].

Among such sustainable construction practices, sustainable material selection plays a vital role which directly influences building sustainability. Conversely, the selection of inappropriate materials leads to ineffective sustainable construction and adversely impacts the economic, environmental, and social aspects of buildings [35–40]. According to studies by Gonzalez and Navarro [41], selecting suitable construction materials may reduce CO₂ emissions by up to 30% [19]. This study considers sustainable material selection as a core concept, and we recognize that other studies include this vital approach. Sapauskas and Turskis [19] affirm that sustainable construction can be versatile, and that different strategies are needed with respect to a country's

economic position, its size, and its culture. Fewer literature resources pursue the specific context of UAE. Radhi [2], for example, analysed the role of UAE construction in global warming through various environmental perspectives and he concluded that UAE buildings directly affect global warming. Gharzelddeen and Beheiry [4] analysed the usage of green design parameters in construction projects in UAE; their study examined 112 projects and evaluated the essential green design parameters and correlated those factors with their constraints. Elchalakani and Elgaali [42] studied sustainable construction through the creation of sustainable concrete, made up of recycled waste water and concrete obtained from construction and demolition waste. Al-Hajj and Hamani [43] reviewed the existing studies which related to the waste management in sustainable construction and suggested some practices to reduce waste generation in UAE sites. Salama and Hana [44] attempted to measure the level of awareness in UAE regarding sustainable construction; they randomly selected 120 samples and concluded that it is a growing strategy for the country. They further recommended that strict legislation on these types of sustainable construction activities be implemented in order to promote sustainable growth. Other gray literatures exist but have not been considered in this study due to reliability concerns. There are few literature resources available that examine sustainable construction within the context of UAE, despite the fact that the construction sector is operating at a peak level. Therefore, this paper seeks to select sustainable construction material based on indicators in the specific UAE context. Sustainable indicators have been examined to determine the best sustainable alternative, and we use quantitative measures to compare information on both the status quo and systemic changes [20,45]. These indicators will benefit high-level managers in their decision making and policy making with regard to sustainable development [20]. While many definitions exist in the current realm of research for sustainability, the most accepted pillars of sustainability are economic, social, and environment [21,46,47]. Hence, this study considers these three pillars by which to categorize indicators for the selection of preferred sustainable construction materials.

In summary of the above points, the objective of the paper is

- (i) to select the suitable sustainable indicator for selecting sustainable construction material,
- (ii) to analyse the influence, relation structure and feedback among each sustainable indicator to reveal the most influential indicator and
- (iii) to propose a model to evaluate sustainable construction materials and to validate these choices within a UAE context.

In order to achieve the above objectives, this paper considers the multi criteria decision making (MCDM) methodology, a method to solve difficult situations when multiple conflicting criteria are deployed; sustainability evaluations in construction

Download English Version:

<https://daneshyari.com/en/article/8115532>

Download Persian Version:

<https://daneshyari.com/article/8115532>

[Daneshyari.com](https://daneshyari.com)