Developing a green building assessment model by decision making methods

Fan Zhang
School of Architecture and Engineering, Yan'an University, Yan'an 716000, China
121604203@qq.com

Keywords: green building assessment tool, survey, decision-making methods.

Abstract: Green building has been a heated topic in both scholastic and professional field. These researches can be categorized into the following areas. Green building assessment tools and rating systems have been one main category to be focused on. This study is about the evaluation of effectiveness of public policies related to green buildings. A critical literature survey was conducted to identify the relevant policies in Chinese context from a project life cycle perspective. In order to develop a green building assessment model, four dimensions, nine indicators and corresponding parameters are highlighted. Meanwhile, five main goals have been determined through survey among expert panel, though the effectiveness of these goals still needs to be tested further through practical application. Meanwhile, recommendations have been made as for the more in-depth research based on decision-making methods.

1. Introduction

Global warming and climate change are urgent issues that have long been focused. It is estimated that buildings lead to approximately one third of the entire use of energy and greenhouse gas emissions. In the UK and across the EU, approximately 40% of CO2 emission is estimated through building usage. From cradle to grave for construction projects, phases of design, construction, operation, disposal and renovation contribute to carbon gas emissions and energy consumption in both directly and indirectly way [1]. Therefore, to achieve a low carbon economy, policies on dealing with sustainability initiatives in each step of buildings are prioritized [2]. Construction and real estate are taken as two leading sectors where green building development techniques would play a considerable role in balancing long-term economic, environmental and social benefits [3].

The term "green" building refers to environmentally friendly techniques and technologies used in the design and construction of the built environment [4]. The Conseil International du Batiment(CIB) defined green building as "… creating and operating a healthy built environment based on resource efficiency and ecological design", [5] green building technology is not only for private buildings but also for public buildings involving residential, commercial as well as office buildings.

Up till now, in most developing countries, green building techniques have still not been widely practiced yet. Given the fact that only a few real-estate developers of green buildings have invested in green buildings in past decades, while contractors are still lack of experience in terms of design and construction of green buildings, reasonable rating system and engineering technical requirement still need to be explored. Meanwhile, intimate cooperation of the contractor and developers is necessary to establish a green building [3].

2. The establishment of a green building assessment model

In recent years, green building has been a heated topic in both scholastic and professional field. These researches can be categorized into the following areas. Green building assessment tools and rating systems have been one main category to be focused on. Many criteria-based rating systems such as the Building Research Establishment Environmental Assessment Method and the Green Building Tool have been produced in different countries to assign values to a selected number of green building criteria on the basis of building performance [6][7]. Cole et al. [8] Ali and Nsairat [9],

Haapo et al. and Liu et al. proposed that green building rating tools could be classified into multi-criteria based methods and the life cycle approaches (LCAs). Rouzbeh developed a green building assessment tool by using decision making methods and geographical information system used in Iran [1]. Chang established a decision model to tackle uncertainty and imprecision of green building project evaluation in terms of structure. Still, another stream of researches is mainly about green building design in technical aspect. Sailor [10] and Pan et al. [11] used simulation tool to study the green roof and the energy consumption respectively. CW. Chang mentioned a method to perfect green building ecosystem involving biodiversity designs and limit to the environmental endurance [12].

In terms of green building, energy efficiency and savings are one of key issues to be achieved. To be specific, it includes energy efficient equipment, suitability of materials, the service and amenities, the embodied energy during the phases of building construction and demolition [13]. Apart from energy indicators, other assessment dimensions, indicators and parameters of green buildings (see Table 1) are developed based on four aspects (environmental, economic, technical, social) during implementation of green building practices.

Table 1: Assessment dimensions, indicators and parameters of green buildings

Dimension	Indicators	Parameters
Environmental	Materials	Local/regional material
		Environmental impact of materials
		Material efficiency over its life cycle (LCA)
		Renewable material and resource reuse
		Building impact of materials
	Pollution	Greenhouse gases emission
		Recyclable waste storage
		Waste reduction & management strategies
Technical	Energy and sources efficiency	Renewable energy technology
		Energy-efficient cooling/heating system
		Efficiency of electricity/ natural gas saving
		Rain water harvesting
		Gray water recycling
		Water conservation
	Indoor environment quality	Increase ventilation efficiencies
		Increase thermal/acoustic /lightning comfort
		Visual quality
		Lighting control
	Innovation	Innovation in design
Economical	Cost and economics	Investment cost of material, labor and commissioning fee
		Payback period
		Financial incentive
		Installation time
		Affordability of rental
		Insurance and taxes
		Investment risk
Social	Occupant satisfaction	Occupant health and safety
		Privacy
		Interior qualities
		Occupant wellbeing improvement
	Accessibilities	Accessibilities to urban amenities
		Accessibilities to public transportation
	Externalities	Available services
		Social benefits analysis
		Local employment opportunities

After indicators have been determined, the goals of green building policies are then gleaned from

literature review and discussed by experts panel. These goals are listed as follows:

1) To provide financial bonus to accelerate green building development.

2) To apply systematic standards to assess the application of green building technically and economically.

3) To cultivate individuals' awareness and prompt the implementation of green buildings.

4) To encourage various stakeholders to engage in green building construction.

5) To raise acceptance level for consumers to pay for improving building performance.

3. Conclusion and recommendation

Indeed, the effectiveness of these goals still needs to be tested through real projects to promote green building developments. Although green building project has witnessed an increase in its application in real life, green building assessment scheme still needs to be more concrete and practical especially when applied in a specific area. Besides, measure shall be taken to achieve goals. For example, efforts are required to strengthen the administrative supervision of the design and construction stage; to release more detailed technical standards; to reduce unnecessary demolition and to prolong the service life of buildings. Furthermore, it is suggested to consider enhancing the public and knowledge of green building as a long-term strategy. More in-depth study is recommended by using the triangle fuzzy matrix transformation evaluation method to enhance the effectiveness of public policies. Meanwhile, methods such as the neural network algorithm (NNA), the genetic algorithm, and the TOPSIS algorithm can be considered for policy evaluation as well.

Acknowledgments

This research is funded by Youth Research Program of Yan'an University. (No. YDQ2017-23)

References

[1] R. Shad et al., Developing an Iranian green building assessment tool using decision making methods and geographical information system: Case study in Mashhad city, Renewable and Sustainable Energy Reviews 67(2017) 324-340

[2] M. Nilashi et al., A knowledge-based expert system for assessing the performance level of green buildings, Knowledge-Based Systems 86 (2015) 194–209

[3] J. Xu et al., Rough approximation based strategy model between a green building developer and a contractor under a fuzzy environment, Knowledge-Based Systems 46 (2013) 54–68

[4] P.E. Love, M. Niedzweicki, P.A. Bullen, D.J. Edwards, Achieving the green building council of Australia's world leadership rating in an office building in Perth, J. Constr. Eng. Manage. 138 (5) (2011) 652–660.

[5] C. Kibert, Sustainable Construction: Green Building Design and Delivery, Wiley, New York, 2008.

[6] Cole RJ, Kernan PC. Life-cycle energy use in office buildings. Build Environ 1996; 31: 307–17.

[7] Lee K, Tae S, Shin S. Development of a life cycle assessment program for building (SUSB-LCA) in South Korea. Renew Sustain Energy Rev 2009; 13: 1994–2002.

[8] Cole RJ, Lidnsey G, Todd JA. Assessing life cycles: Shifting from green to sustainable design. In: Proceedings of the International Conference Sustainable Building; 2000. 22–4.

[9] G. Kim, H.S. Lim, T.S. Lim, L. Schaefer, J.T. Kim, Comparative advantage of an exterior shading device in thermal performance for residential buildings, Energy Build. 46 (2012) 105–111.

[10] D. Sailor, a green roof model for building energy simulation programs, Energy and Buildings

40 (2008) 1466–1478.

[11] Y. Pan, R. Yin, Z. Huang, Energy modeling of two office buildings with data center for green building design, Energy and Buildings 40 (2008) 1145–1152.

[12] CW. Chang, Develop a ranking algorithm for the green building project, Business Media Dordrecht (2012)

[13] AH. Abu, a framework for assessing the sustainable urban development. Social Behavior Science (2013) 85:484–92.