Building and Environment 96 (2016) 107–117

Contents lists available at ScienceDirect

Building and Environment

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

Objective conflicts in green buildings projects: A critical analysis

Qian Shi [a], Yu Yan [a], Jian Zuo [b, *], Tao Yu [a]

[a] Department of Construction Management and Real Estate, School of Economics and Management, Tongji University, Siping Road 1239, Shanghai 200092, China

[b] School of Architecture & Built Environment, Entrepreneurship, Commercialisation and Innovation Centre (ECIC), The University of Adelaide, Adelaide, Australia

ARTICLE INFO

Article history:
Received 9 July 2015
Received in revised form
6 November 2015
Accepted 18 November 2015
Available online 2 December 2015

Keywords:
Green buildings
Objective conflict
Rough set theory

ABSTRACT

The construction industry has significant environmental, social and economic impacts on the society. As a result, the last decades have witnessed the rapid growth of the green building sector in order to mitigate the negative impacts associated with construction related activities. Similar to conventional building projects, green building projects have a variety of objectives that may not necessary be compatible. These include upfront cost vs. ongoing savings; and energy savings vs. building users' health and wellbeing. In China, it has been reported that some green buildings consume 26% less energy compared to conventional buildings. However, due to the incremental cost, it is not uncommon that enterprises and governments in China are unwilling to bear this kind of risk. This has presented significant challenges to industry practitioners as they are also facing extra demands related to sustainability. This research aims to investigate the conflicts amongst various objectives of green building developments. A theoretical framework was established to depict the potential conflicts amongst various objectives of green building projects across its life cycle. This theoretical framework was tested with empirical data collected via semi-structured interviews. Rough set theory was employed to investigate the conflict degree amongst various project objectives from stakeholder's point of view. Implications were discussed and recommended to resolve these conflicts.

1. Introduction

It is well recognized that the building sector has significant impacts on the society, environment and economy [1–3]. For instance, the excessive energy consumption of the building stock and associated environmental issues has attracted a growing public concern worldwide [4–6]. As a result, a lot of efforts have been made to mitigate the negative impacts of building developments throughout its entire life cycle [7–9]. One of these efforts is promoting green building developments where the governmental policies and user's behavior play a crucial role [10,11]. To facilitate the green building developments, rating tools have been developed such as the LEED (US), BREEAM (UK) and GBCA (Australia) that provide necessary guidelines. Previous studies have shown that these rating tools are very useful to promote the development of green building industry [12]. A number of studies have reinforced that certified green buildings generally provide significant environmental benefits such as less energy consumption, improved energy efficiency, less construction and demolition waste, and improved water efficiency [13,14]. From building operation's perspective, there are also benefits such as cost savings, enhanced organizational image and improved working efficiency of building users [15,16]. These benefits will then be reflected on the increased value or premium of the property [17]. However, some studies questioned the claimed benefits of green building developments. For example, Newsham et al.'s study found that some 30% of LEED certified buildings consumed more energy than conventional buildings despite a better level of energy efficiency on average [18]. It is worth noting that continuous improvement of green building rating tools is required. For instance, Xia et al.'s study found that materials-related credit points were more difficult to be awarded under the GBCA rating scheme than under the LEED scheme [19]. Efforts are required to clarify related requirements so that applicants are able to respond properly in design and certification documents.

It is also worth noting that the green building development is a complex system which involves a variety of objectives. These

* Corresponding author.
E-mail address: sageorgezuo@yahoo.com.au (J. Zuo).

http://dx.doi.org/10.1016/j.buildenv.2015.11.016
0360-1323/

objectives include: economic benefits, environmental benefits, social benefits, functionality, and user's comfort [20,21]. These objectives are not always compatible. As a result, conflicts may rise amongst various objectives of green building developments. For instance, performance is a parameter for all building projects no matter 'green' or not. Some of the green rating systems require a real proof on performance, e.g. GBCA Green Star Performance. The pursuing of environmental performance of building may lead to less comfort of building users. It has been reported that there are significant overheating risks associated with green buildings that rely on natural ventilation predominately during the summer season [22–24]. A business case could be put forward to justify the higher capital cost associated with green buildings by leveraging through long-term energy cost savings [25,26]. Similarly, other intangible benefits such as improved productivity of tenants could be used to justify the higher upfront cost [27,28]. However, there is no lack of criticism on green building developments. For example, the open space office encouraged by green building design guidelines has led to issues such as disturbance to other employees due to noise and lack of privacy [29]. Similarly, there have been some concerns on the thermal comfort at certain locations of certified green buildings such as high level of humidity and higher temperature experienced during the summer season [30].

Indeed, the capacity to manage conflict system in a project is crucial for a successful project manager. Turner & Simister defined conflict system as "… one in which individuals have objectives that are not jointly consistent" [31]. There are a large number of objectives of project management such as time, cost, quality, functionality and stakeholder satisfaction. It presents significant challenge to manage the potential conflicts between these objectives. This is compounded by the extra requirements on sustainability features and performance in green building projects. For example, Hwang & Ng pinpointed that the management of green building projects are more demanding on competencies on cost management and communication management compared to those of conventional building projects [32]. This is arguably due to the higher capital cost associated with and large number of stakeholders involved in green building projects. Li et al.'s study found that project managers should pay more attention to the coordination between design consultants and the construction team as well as technological innovation so that the possibility of success in green building projects can be enhanced [33].

Despite growing awareness and recognition of sustainable development in the built environment, there is lack of systematic studies on the conflict system within green building developments. This study aims to address this gap of knowledge by establishing a theoretical framework for conflicts amongst various objectives of green building developments throughout the entire project life cycle.

2. Objective system of green building projects

Based on the related literature [34–37], a theoretical model is established in this study for the objective system of green building projects. This theoretical model consists of two dimensions. The horizontal direction depicts five project stages for the entire life cycle of green building projects (see Fig. 1):

In the vertical direction, the objective system of green building projects is divided into 4 layers. The first one is total objective layer, which addresses the success of green building projects throughout the entire life cycle as the ultimate objective. The second layer contains three kinds of sub-objectives, i.e. economic objective, social objective and environmental objective in order to meet the demands of green building from the perspective of economy, society and ecology respectively. In addition, these three aspects are mutual dependent and constrained. The third layer goes on subdividing the higher level indicators. At last, objectives of the fourth layer are the final indicators that are measurable and verifiable for the evaluation purpose.

Consequently, related previous studies were reviewed in order to have a further understanding of objective conflicts in green building projects in different project stages [35,38,39]. As a result, final set of indicators were defined according to project stages (see Table 1).

As shown in Table 1, the first branch of "Economy Objective" is "Cost Effectiveness", which means the saving of costs. Therefore, the evaluation indicators of this class contain all kinds of costs that may occur in the entire life circle of green building projects. These include cost related to feasibility, design planning, construction, operation and maintenance, and demolition and recycling. The second branch of "Economy Objective" is "Functional Effectiveness", which can be further divided into Safety, Comfort and Artistry. All of these three indicators present functions of green building projects from the beginning to the end. Especially, the indicators associated with Safety and Comfort is related to the users of green buildings. Therefore, these indicators are further divided into specific sub indicators in different project stages. The last branch of "Economy Objective" is "Schedule Effectiveness", which is used to measure whether the green building project is delivered on time.

Environmental Objective consists of "Green Certification" and "Long-Run Performance". Firstly, the fourth level objective "The Green Building Evaluation System" should be given a further description, i.e.: on the basis of "Evaluation Standard for Green Building (GB50378-2014-Residential Building)"in China this study. In this evaluation standard, green buildings are assessed from eight aspects: Land Saving and Outdoor Environment, Energy Saving and Utilization, Water Resource Saving and Utilization, Material Resource Saving and Utilization, Indoor Environmental Quality (IEQ), Construction Management, Operation Management and Innovation Evaluation. Furthermore, the certification is conducted in two stages, i.e. Design and Operation where the weighting of items varies. In this research, the detailed indicators of these six aspects are divided into different project stages (see Table 2).

As shown in Table 2, the Chinese Green Building Certification system pays more attention to the operation & maintenance stage and design stage, with the score of 8.65 and 7.25 respectively. In the operation and maintenance stage, the main objectives are the reduction of the equipment's energy consumption and the improvement of users' comfort levels. Materials and types selection of structure or equipment, and environmental conservation of decoration are the main focuses during the design stage.

Similarly, Environmental Objective contains "Long-Run Performance", which refers to the condition of green building's structure,

Fig. 1. Whole life cycle of green building.