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Identifying the critical factors for green construction – An empirical study in China

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A B S T R A C T

Construction activities have significant impacts on the community and environment. As a result, green construction has been promoted to mitigate these issues. A questionnaire survey was conducted with major stakeholders of the construction industry in Shanghai to investigate issues associated with the adoption of green construction. The results showed that additional cost, incremental time and limited availability of green suppliers and information are critical barriers. Discussions were made to breakdown these barriers to foster green construction practice. This study provides a useful reference to both policy makers and industry practitioners to implement green construction.

Introduction

Although green construction has been attached more importance recently, obstacles still exist to its widespread adoption (Meryman & Silman, 2004 in New York; Ofori & Kien, 2004 in Singapore; Lam, Chan, Chau, Poon, & Chun, 2009 in Hong Kong). In the last few decades, the green construction concept has gained rapid development in China as a result of strong national policies on energy conservation and emissions reduction. In the early 1980s, the government attempted to promote energy efficiency. Led by the Ministry of Construction (MOC), the first industry standard for energy conservation design of residential buildings (JGJ26-86) was introduced in 1986. With the help of the China Academy of Building Research (CABR), MOC issued a revised version (JGJ 26-95) in December 1995. Since then, many other codes have been introduced to different energy conservation design areas of residential buildings in China (e.g. JGJ129-2000, JGJ134-2001, JGJ132-2001, JGJ75-2003, etc.). A national design standard for the energy efficiency of residential buildings covering the whole of China was published in 2004 (DBJ 01-602-2004). These are closely related to sustainable human settlements in both urban and rural areas. Related to this, a national standard for energy efficiency design of public buildings (GB50189-2005) was issued by MOC in 2005. The Law of the People's Republic of China on Energy Conservation passed the Standing Committee of the National Congress in 1997 (then revised in 2007), which was the first ever legislation in energy management with provisions of encouraging exploitation, the utilization of new energy sources and the promotion of energy-saving technologies. The Renewable Energy Law was effective in 2006 (revised in 2010) to promote the renewable energy development with the aim of saving conventional energy sources and improving energy efficiency. MOC announced the Provisions on the Administration of Energy Conservation for Civil Buildings (2000) to facilitate the implementation of Law on Energy Conservation. It established the building energy efficiency standards on programming, design, construction, project quality supervision and operational management of construction projects. In July 2008, the State Council promulgated the Regulations of Energy Conservation for Civil Buildings, which had more operable, mandatory and comprehensive provisions on energy conservation for new building construction and retrofitting of existing buildings, building energy system management, energy efficiency evaluation, and corresponding legal responsibility.

Green construction in China can be traced back to China's Agenda 21 published by State Council (1994) with a consideration of sustainability issues associated with both urban and rural areas. From then on, the Chinese government has enacted policies and standards on green demands of construction industry to protect the environment, including inside pollution control (2001) and construction material quality (2002). Subsequently, since the 2004 Beijing Olympics Games, the government has begun to further promote green construction practices. The Assessment System for Green Building in the Beijing Olympic (GBCAS) was established by the Beijing Olympics Organizing Commission (2003), which introduced a set of Guidelines for the implementation of Green Olympics. The

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GBCAS covers the technical criteria and a set of assessment systems. The 2010 Shanghai World Expo has drawn on the experience of green construction within a multi-project (programme) environment from the Beijing Olympics Games for its pavilion developments. Shi, Zuo, and Zillante (2012) pointed out that the sustainable construction management at the programme level is different from that at the project level. They pointed out that a dedicated department should be established in order to coordinate various stakeholders' efforts and the release of conceptual guideline and management regulations.

Green construction is defined as "On the premise of ensuring quality, safety and other basic requirements, scientific management and technological progress should be used in engineering construction, to maximize the conservation of resources and reduce the construction activities which will bring negative impacts on the environmental, and to achieve the goal of four savings (energy, land, water and materials) and environmental protection", which is specified in the Green Construction Guideline issued by MOC in 2007. According to this Guideline, green construction is classified into six parts, i.e. construction management, environmental protection, material conservation and utilization, water conservation and utilization, energy conservation and utilization, land conservation and construction using land protection. The five factors in the construction process "man, machine, material, method and environment" are all covered by these six aspects.

Despite the recognition of the importance of specifications in the application of green construction, there are very limited studies on the stakeholders' perceptions of potential barriers to introducing green specifications into construction in China. In this research, the current status of green construction and potential barriers are investigated through a questionnaire survey in Shanghai, which has a construction scene similar to many other urban cities in the world. Therefore, the aims of this research lay in three parts: (1) investigate the development situation and research status of green construction in China; (2) classify the general barriers to the implementation of green construction in China by questionnaire survey; (3) propose initiatives to push forward an integrated system between government and contractors for green construction.

Barriers to green construction

It has been generally recognized that environmental issues are critical in the construction industry. Hill and Bowen (1997) proposed a framework for sustainable construction, which highlighted that environmental issues should be included in the specifications and other contract documents related to the implementation of environmental tools such as an environmental management system and an environmental impact assessment. According to Crawley and Aho (1999), "green" design and specifications are critical for construction projects, especially those subjected to environmental assessment.

Meryman and Silman (2004) identified 3 primary barriers for using specifications in sustainable engineering. They argued that the economic factor was the most critical barrier, apart from policy and technical issues, which could be translated to green construction in China. Li and Yao (2009) argued that emerging issues relating to building energy conservation were due to a more rapid growing economy and urbanization development in China (see also Zhang, Bai, Chang, & Ding, 2011). Due to the higher population and building density and less availability of reusable energy per square metre floor area, the development of sustainable building technologies applicable to various conditions in China is more necessary (Zhu & Lin, 2004). According to Liu, Low, and He (2012), construction industry practitioners in China are more motivated to adopt green practice in order to secure "countenance and incentives from the government". Presently, many developers are still reluctant and uncertain about the adopting sustainability in their projects due to limited understanding and the pursuit of cost reductions in developing countries such as China. Abidin (2010) considered that the pace of action towards sustainable application depended on the consciousness, knowledge as well as an understanding of the consequences of individual actions. A survey by Qi, Shen, Zeng, and Jorge (2010) showed that managerial concern was the most important driver for the adoption of green practices by contractors. According to the above research, the main barriers of green construction were classified into 4 fundamental aspects, i.e. economics, technology, awareness and management, where 15 potential barriers were identified (see Table 1).

Economics

Cost

It is well recognized that cost effectiveness is one of the most important considerations for decisions of implementing green construction (Kunzlik, 2003; Meryman & Silman, 2004). Ofori and Kien (2004) argued that the extra cost occurred is the fundamental barrier for implementing green construction. The utilization of green techniques such as high performance insulation protection, water and energy saving equipment often increase the capital cost. In fact, cost control presents the biggest challenge to implement green practices in China (Liu et al., 2012). To assist the promotion of green construction, a life cycle approach should be considered during the assessment of relevant cost and impacts (Shi et al., 2012).

Time

Chan and Kumaraswamy (2002) stated that the schedule serves as a crucial benchmark for the performance (apart from cost) of construction projects. Time is a prime project objective for all stakeholders in most countries (Ofori & Kien, 2004). Delays in construction often result in increased costs and cause damage to stakeholders, as well as affecting the reputation of corporation (Arditi & Pattanakitchamroon, 2006). Green construction demands integration of sustainable technologies and interaction with other building components (Hoffman & Henn, 2008). Hwang and Ng (2012) argued that delays will be caused if this issue is not taken into consideration thoroughly.

Table 1
Potential barriers to implementing green construction. Adapted from Lam et al. (2009).

Economics
Cost
B01 Additional costs caused by green construction
Time
B02 Incremental time caused by green construction
Technology
B03 Reduction of structure aesthetic
B04 Uncertainty in the performance of green materials and equipment
B05 Imperfect green technological specifications
B06 Misunderstanding of green technological operations
B07 Restrictions of new green production and technology
Awareness
B08 Regional ambiguities in the green concept
B09 Conflicts in benefits with competitors
B10 Dependence on promotion by government
Management
Construction Management
B11 Lack of support from senior management
B12 Lack of knowledge on green technology and materials
B13 Limited availability of green suppliers and information
B14 Lack of quantitative evaluation tools for green performance
Contract management
B15 Additional responsibility for construction maintenance