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Exploration of critical resources and capabilities of design firms for delivering green building projects: Empirical studies in Singapore

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A B S T R A C T

Green Building (GB) has attracted more attention in recent years and many studies have been conducted in project delivery of GB. In Singapore, the compulsory requirement of Green Mark, one certification for GB, drives the rapid development of GB Market. The purpose of this research is to identify the critical resources and capabilities of design firms that should be cultivated in order to help their projects achieve higher ratings of Green Mark effectively. Firstly, potential important organizational factors were explored through literature review. Then, these factors are ranked based on data collected in a questionnaire survey. "Experience and knowledge in GB", "organizational green culture" "innovation capability" were found more important than other factors. Finally, the findings were tested by using a qualitative case study approach and two case companies in Singapore were investigated. The results of case studies not only validated the findings obtained from quantitative analysis, but also provided more in-depth additional reasons for the identified factors.

Introduction

In recent years, Green Building (GB) becomes more popular and investigating the factors affecting the success of GB projects in construction has attracted the interest of many researchers and practitioners. For example, Eriksson and Westerberg (2011) put forward that cooperative procurement procedures (joint specification, selected tendering, soft parameters in bid evaluation, joint subcontractor selection, incentive-based payment, collaborative tools, and contractor self-control) generally have a positive influence on project performance not only in cost, time, quality, but also in environmental performance of construction projects. Korkmaz, Riley, and Horman (2010) explored the important factors for successfully delivering GB projects with "owner commitment", "project delivery system", "project team procurement", "contract conditions", "design integration", "project team characteristics", and "construction process" as independent variables and schedule, cost, quality and sustainable high-performance as dependent variables. As a result, "timing of project participants' involvement in the delivery process" and "owner type" were found to be important factors for project outcomes. In Lapinski, Horman, and Riley (2006) research work, five core value-added processes that contribute to delivering GB were identified: (1) their decision to evaluate and adopt sustainable objectives very early in the process, even as early as capital budgeting; (2) the alignment of sustainable objectives to the business case of the project; (3) the identification and pursuit of building features that naturally align with sustainability; (4) the selection of an experienced design and construction team early in the project, and (5) investing time to align individual team member goals with project goals. Enache-Pommer and Horman (2009) identified top three attributes: "owner commitment", "expertise on sustainable delivery" and "early timing of sustainable objectives" in the delivery of green hospitals. The impacts of main delivery methods, including design-bid-build (DBB), construction manager at risk (CMR), and design build (DB) for achieving GB projects were also investigated in Molenaar et al.'s (2009) research work. The critical project management factors for delivering GB projects in Singapore were also studied by Li, Chen, Chew, Teo, and Ding (2011). The important project management knowledge and skills of project managers for execute green construction were also explored recently (Hwang & Ng, 2013).

However, it appears that all these research work emphasized more on project-related factors. It should be noted that some project organizations are affiliated to their parent firms, which may run a few construction projects simultaneously. Therefore, project

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performance is somewhat influenced by the resources and capabilities of the parent organizations. Actually, the impacts of corporate strengths/weaknesses on project management performance were investigated by Isik, Arditi, Dikmen, and Birgonul (2009). Construction is a multi-organization process, which includes the participation of client/owner, designer, contractor, supplier, and consultant. To achieve sustainability, all actors should cooperate together. However, among them, the designers, including architect and engineers, play a critical role in environmental performance of building projects. Specific elements considered in the design phase include sustainable site development, integrated building systems design, energy and water efficiency, sustainable material use, and indoor environmental quality (Vanegas, 2003). For example, simply making buildings the right shape and the correct orientation can reduce the energy consumption by 30–40% at no extra cost (Zukowski, 2005). The importance of designers on GB projects has been realized. However, no research effort emphasizes on design organizations behind projects, especially impacts of organizations' resources and capabilities on the environmental performance of building projects, it is essential to conduct comprehensive studies on this problem.

Green Mark, GB assessment system in Singapore, was launched in January 2005 by the Singapore Building and Construction Authority (BCA). This assessment system evaluates the environmental performance of building projects in five areas: (1) Energy Efficiency; (2) Water Efficiency; (3) Site and Project Development and Management; (4) Indoor Environmental Quality and Environmental Protection; and (5) Innovation. Depending on the total points awarded for each of these five areas, one of the four ratings can be awarded: Platinum, Gold^{Plus}, Gold, and Certified. Starting from 15 April 2008, all new buildings with Gross Floor Area of more than 2000 m^2 are required by law to meet the minimum Green Mark standard. The master plan of BCA is to achieve "80 percent of all buildings in Singapore to be certified Green Mark by 2030". It indicates GB will become a new dominant market in Singapore in the near future, and the current corporate practices of design firms need to respond to the requirements of Green Mark. However, the resources and capabilities that should be available for design firms to facilitate the projects they undertake to achieve good Green Mark ratings are still vague from corporate viewpoints. Therefore, the purpose of this study is to explore the necessary resources and capabilities of design firms for better delivery of Green Mark certified projects in Singapore.

Literature review

In order to have a clear and detailed understanding of the resources and capabilities of design firms, Resource-Based View (RBV) and Cheah's Conceptual Model, which can help investigate competitive advantages of firms, are used. Although they are usually used for strategy analysis for firms, they can help investigate internal resources at the firm level.

Firm resources are commonly controlled by the firm that enables the firm to conceive and implement strategy and improve its efficiency (Daft, 1983; Penrose, 1959). Barney (1991) described firm resources as attributes that: "include all assets, capabilities, organizational processes, firm attributes, information, and knowledge". Rechenthin (2004) pointed out that firms' resources can be people, financial, brand names, technology, machinery, land, contracts, managerial skills, and similar assets. According to Man (2001), resources in a firm can be classified into financial, physical, human, organizational and technological resources. In Isik et al.'s (2009) research work, a company's resources and capabilities were defined as financial resources, technical competencies, leadership characteristics, experience, and image in the industry and innovation tendencies. Generally, most researchers agreed that internal assets can be classified into tangible and intangible resources. Tangible resources include financial resources, physical resources, human resources and organizational resources. Intangible resources comprise technological resources, resources for innovation and reputation (Barney, 1991). The RBV is a conceptual framework for understanding firm-level growth using resources as building blocks.

Cheah (2002) classified the internal resources of large global engineering and construction firms into seven strategic fields: business strategy, operational strategy, IT strategy, marketing strategy, technology strategy, human resource, and financial strategy. Two internal mechanisms of organization (organizational structure and culture) were also identified. Any discussions of corporate strategy should always parallel the internal mechanisms of an organization. These issues exist at the corporate level and are embedded in the very lifeblood of the organization, and hence reflect the corresponding firm-specific resources and capabilities (Cheah & Gurvin, 2004). As a corollary, organizational leaders should treat the seven strategic fields and the two internal mechanisms of organization as variables building blocks of corporate strategy – these lie within the boundary and can be controlled by the firm (Cheah & Gurvin, 2004). Fundamental components of an organization were identified by previous studies and summarized in Table 1. The effects of these resources and capabilities of design firms on GB projects are discussed in detail as follows.

Financial capability is the ability of firms to use financial resources as medium of exchange for other productive resources (Chatterjee & Wernerfelt, 1991). Having strong financial resources may enable a company to get into more risky situations which in turn have higher benefits (Isik et al., 2009). Generally, the process of designing GB projects is much more complex due to the implementation of new technologies, materials and products. Every detail should be paid enough attention to ensure that no assessment points are lost due to carelessness. Therefore, delivering GB projects often involved with more risks than delivering traditional projects. The sufficient budget also serves to cater for any unexpected cost increase (Yang, 2006).

Technical competency refers to the physical assets of a company such as machinery and equipment and the extent of technical know-how available that is necessary to undertake specific projects (Isik et al., 2009). GB often requires minimizing energy consumption, improving indoor air quality, minimizing heat island effect, minimizing wastage, as well as effective usage of resources, which are all based on new science, new technology, or advancing software to find the optimum alternative. For example, how design parameters affect energy consumption of buildings should be studied by more accurate and advanced simulation software to help make decisions. Therefore, high technical capability of design firms is necessary to help achieve environmental objectives of GB projects.

"There is a direct and positive relationship between project team member experience and project outcomes." (Young & Samson, 2008). Firms can actually improve their project

Table 1
Summary of organizational resources.

Organizational factors	Man (2001)	Rechenthin (2004)	Barney (1991)	Isik et al. (2009)	Cheah (2002)
Financial strength	√	√		√	√
Technology competency	√	√		√	√
Experience and knowledge			√	√	
Human resources	√	√			√
Company image		√		√	
Innovation capability				√	
Organizational structure					√
Organizational culture					√