

# **Are Project Managers Ready for Green Construction?**

## **- Challenges, Knowledge Areas, and Skills –**

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### **Abstract**

Global concerns over climate change and sustainability have spurred the need for green construction. With the rising number of green construction projects, it is necessary to ensure that such projects are delivered successfully. Considering that a competent project manager is vital to project success, it is therefore essential to identify the critical knowledge and skills that a project manager needs to effectively execute a green construction project. As a result, the objectives of this study are: (1) to discover the challenges that project managers encounter in managing green construction projects; and (2) to determine critical knowledge areas and skills that can respond to the challenges. Through literature review, surveys with 30 project managers, and interviews with three project managers, “the longer time required during the pre-construction process”, “difficulty in the selection of subcontractors who provide green construction services”, “uncertainty with green materials and equipment”, “the high cost of green materials and equipment”, and “increased meetings and coordination required with green consultants and engineers” were identified as the top-five ranked challenges. Furthermore, the most important knowledge areas that will respond to the challenges were “schedule management and planning”, “stakeholder management”, “communication management”, “cost management”, and “human resources management”. In addition, the most important skills that are required to mitigate the challenges were “analytical”, “decision-making”, “team working”, “delegation”, and “problem-solving skills”. The findings from this study will help establish a knowledge base for project managers to be competitive and to effectively execute sustainable projects.

**Keywords: Project Manager, Project Management, Knowledge Areas, Skills, Green Construction, Singapore**

### **1. Introduction**

Having a competent project manager is vital to project success. Several studies (Avots, 1969; Sayles and Chandler, 1971; Belassi and Tukul, 1996; Crawford, 2000) highlighted critical roles of project managers for project success, and especially Frank (2002) reported that project managers have direct influence over 34% to 47% of project success. To manage a project professionally, a project manager needs to possess the required skills and knowledge. However, given the fast changing environment of the construction industry with

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challenges such as skills shortages, the rapid advancement of information and communication technologies, and the increasing prioritization of issues such as sustainability, environmental protection and climate change, the role of the project manager needs to be adapted.

According to Perez-Lombard et al. (2008), commercial and residential buildings combined comprise 20% to 40% of the world's energy consumption, while In Singapore, buildings account for 16% of the nation's total energy consumption. With the mounting global concern for the environment, many industries are steering towards sustainable development and implementing green measures. In line with this trend, building construction companies from various regions around the world have integrated green features into their construction plans (Hwang and Tan, 2012), and Singapore has made sustainable development a key national priority as well (Singapore Green Building Council, 2009).

As the green building construction phenomenon continues to grow and gain popularity, there is a need to better understand the pivotal attributes that project managers should possess to manage green construction projects. Despite numerous studies on a project manager's competency, few have specifically examined what skills the project manager will need to successfully deliver a project requiring sustainable construction. As a result, with the intent to enhance sustainability efforts without compromising the competitiveness of project managers, this study aims: (1) to discover the challenges that project managers encounter in managing green construction projects; and (2) to determine critical knowledge areas and skills that can respond to the challenges.

## **2. Literature Review**

### **2.1 Challenges of Green Construction Projects**

Based on the comprehensive literature review carried out for this study, the major challenges that project managers face in managing green construction projects were identified and are discussed in the following sub-sections.

**Higher Costs for Green Construction Practices and Materials:** As compared to conventional projects, green projects tend to cost more to construct. According to an estimate by Tagaza and Wilson, (2004) capital costs for green projects range from 1 to 25% higher. The higher costs are due to design complexity and the modeling costs needed to integrate green practices into projects (Zhang et al., 2011). Higher costs are also associated with green materials and using green construction technologies (Hwang and Tan, 2012). Zhang (2011) calculated that using green materials costs from 3 to 4% more than conventional construction materials. Some green materials cost significantly more than their conventional counterparts, compressed wheat board costs about ten times more than ordinary plywood (Hwang and Tan, 2012). The higher costs of green construction directly affect the project manager, because they are responsible for managing and delivering their projects within an allocated budget (Ling, 2003).

**Technical Difficulty during the Construction Process:** A project manager implements a project plan by authorizing the execution of activities to produce project deliverables (Ling, 2003). Often, green technologies require complicated techniques and construction processes (Zhang et al., 2011). If complexities are not addressed well then it may affect the project manager's performance. Tagaza and Wilson (2004) suggested that one of the main challenges in green building is the technical difficulties experienced during the construction process. Similarly, design can be more complicated than that of a conventional building due to the evaluation of alternative materials and systems (Hwang and Tan, 2012).

**Risk Due to Different Contract Forms of Project Delivery:** Tagaza and Wilson reported that the success of developing and implementing a green design depended greatly on the type of contract selected for the delivery of the project (2004). The type of contract used in green projects must incorporate the details of a fully integrated green design. This creates a problem if the design is locked before being developed fully (Tagaza and Wilson, 2004). Multiple changes of significant scale are likely if green features are incorporated at a later stage, resulting in a greater overall project cost (Hwang and Tan, 2012).

**Lengthy Approval Process for New Green Technologies and Recycled Materials:** The market environment suggests that the planning process can be protracted as the process of approving the use of new green technologies and recycled materials can be lengthy (Tagaza and Wilson, 2004). Similarly, surveys conducted by Zhang et al. (2011) and Eisenberg et al. (2002) show that additional time is expected in order to gain approval. A lengthy approval process presents a challenge to project managers as they must develop the schedule and approve progress payments to vendors and suppliers (Ling, 2003).

**Unfamiliarity with Green Technologies:** Many studies have verified that green technologies pose certain obstacles for developers, clients and contractors. Two reasons suggested by Eisenberg et al. (2002) are insufficient knowledge or technical expertise and unfamiliarity with the products, materials, system, or design. The main challenge is that green technologies are usually more complicated and are different from conventional technologies (Tagaza and Wilson, 2004). This was confirmed by Zhang et al. (2011). A project manager has to deliver the project with the required performance specified by the client (Ling, 2003), and unfamiliarity with the performance of green technologies may affect the performance outcome.

**Greater Communication and Interest Required amongst Project Team members:** To be successful, the project manager must manage a large number of suppliers, subcontractors and team members. Communication is especially critical for the green project in order to convey the sustainable practices expected from the team members. Interest amongst team members is important, Tagaza and Wilson (2004) found that the initial enthusiasm for separating waste materials amongst sub-contractors dissipated as the projects progressed and the recycling skips were found to contain a mix of materials.

**More Time Required to Implement Green Construction Practices on Site:** Random checks and on-site visits by project managers are usually required to ensure that sustainable practices are implemented on-site (Tagaza and Wilson, 2004). This is essential because

workers may tend to forego time-consuming sustainable practices when there are time pressures to complete a project.

## 2.2 Knowledge Areas & Skills of Project Manager

Project Management Institute (PMI) first documented its nine knowledge areas (Integration, Time, Cost, Procurement, Quality, Communication, Human Resource, Scope and Risk) in the Guide to the Project Management Body of Knowledge (PMBOK Guide) in 1987 in an attempt to document and standardize generally accepted project management information and practices (PMI, 2008). Each of the nine knowledge areas contains processes that need to be accomplished within its discipline in order to achieve an effective project management program. Dogbegah (2009) identified eighteen project management competency areas and the argument in the finding is that project management must be conceptualized beyond the commonly emphasized project administration expertise. In addition, Edum and McCaffer (2000) stated that acquiring the knowledge inputs for a particular type of project enables the project manager to develop two types of skills. These are specific skills, which relate directly and only to construction projects, and in particular, the areas that reflect their specialty; and general skills, which are transferable from the construction arena to other fields, but more importantly from one type of construction to another. The general skills provide much of the foundation for developing project management skills. They are often essential for the project manager to function effectively with knowledge specialists. Table 1 lists the knowledge areas and essential skills required for an effective project manager, based on previous studies.

**Table 1: Knowledge Areas & Skills**

Knowledge Areas	References	Skills	References
Schedule management and planning	Project Management Institute (2008); Dogbegah (2009); Odusami (2002); Gushgar et al. (1997); Kerzner (1989); Ling (2004)	Basic technical skill	Edum-Fotwe & McCaffer (2000); Odusami (2002); Gushgar et al. (1997); Fraser (1999); Tett et al. (2000)
Cost management		Site layout and mobilization	
Quality management		Estimating and tendering	
Human resources management		Design activities and background	
Risk management		Reading & understanding drawings	
Supply chain management		Technical writing	
Claims management		Leadership	
Knowledge management		Decision making	
Health and safety management		Problem solving	
Conflict and dispute management		Negotiation	
Ethical management		Human behavior	
Stakeholder management		Delegation	
Information technology management		Team working	
Communication management		Stress handling	
Materials resources management		IT skills	
Financial management		Drafting contracts	
Plant and equipment resources		Presentation	
		Report writing	
	Public speaking		
	Marketing and sales		
	Chairing meetings		
	Public relation		

### 3. Methodology

A pre-survey questionnaire was developed to validate 39 knowledge and skill areas that had been identified through the literature review. A total of 52 completed pre-survey questionnaires were returned and analysed with the use of the mean value ranking method. As the result of the analysis, the top 20 knowledge and skill areas were selected and eventually adopted for the main survey. In addition, interviews with three project managers were conducted to fine-tune the list of challenges that project managers face in managing green construction projects. The results from the pre-survey and interviews served as a platform in developing the main survey questionnaire.

The purpose of the main survey was: (1) to discover the challenges that project managers encounter in green construction; and (2) to identify critical attributes that project managers need to possess in managing green construction projects. The first section of the survey questionnaire captured the respondent's profile. The second section listed the challenges and the respondents were asked to rate the extent to which each of the challenges affected them using a five-point Likert scale (1 = not relevant at all; 5 = most relevant). The last section asked the respondents to rate the importance of project manager attributes in responding to the different challenges (1 = not important at all; 5 = most important).

Out of the 500 questionnaires sent out, 30 sets of completed survey questionnaires were received and analyzed. All the respondents had more than 4 years of experience in managing traditional projects and had some experience with green construction projects (Up to 1 year – 7%; 1 to 2 years – 17%; 2 to 3 years – 23%; 3 to 4 years – 23%; more than 4 years – 30%).

### 4. Data Analysis and Discussions

#### 4.1 Top 5 Challenges faced in Green Construction Projects

Table 2 summarizes the analysis results with 36 specific challenges categorized into seven areas, their mean scores and ranks across the categories. Due to the page limit, only top five challenges are discussed in this section.

**Table 2: Overall ranking of the Challenges**

Category	Challenge	Mean	Rank
Planning-related	Adoption of different contract forms of project delivery	3.20	28
	The design, orientation and structure of the building	3.33	27
	<b>Planning of different construction sequence</b>	<b>4.20</b>	<b>8</b>
	<b>Planning of different construction technique</b>	<b>4.13</b>	<b>10</b>
	Lengthy approval process for new green technologies within the organization	2.43	36
	<b>Longer time required during the pre-construction process</b>	<b>4.57</b>	<b>1</b>
	<b>Difficulty in comprehending the green specifications in the contract</b>	<b>4.27</b>	<b>7</b>

<b>Project-related</b>	Difficulty in approving payment disbursement to suppliers and subcontractors	3.07	33
	Difficulty in assessing the progress of completion in green construction	2.97	34
	<b>Difficulty in the selection of subcontractors in providing green construction service</b>	<b>4.50</b>	<b>2</b>
	More time is required to implement green construction practices onsite	3.97	15
	<b>More alteration and variation with the design during the construction process</b>	<b>4.37</b>	<b>6</b>
<b>Client-related</b>	Specific budget specification of the green project	3.77	20
	Objective of the building project	4.01	14
	Required date of completion	3.67	21
	Level of risk the client is willing to take in green technologies	3.97	16
	Client uses a lot of time in making decision	3.63	22
	Special request from client pertaining to specified green technologies to be used	3.93	18
<b>Project team-related</b>	Conflict with the architect over the type of material to be used	3.17	29
	Lack of communication and interest among project team members	4.10	11
	<b>Frequent meetings with green specialists</b>	<b>4.37</b>	<b>5</b>
	Green consultant delay in providing information	3.13	30
	Conflict of interest between consultant and project manager	3.53	24
	Specific performance required for green building projects	2.53	35
<b>Material &amp; equipment-related</b>	<b>High cost in green material and equipment</b>	<b>4.43</b>	<b>4</b>
	<b>Uncertainty with green material and equipment</b>	<b>4.50</b>	<b>3</b>
	Availability of green material and equipment	4.01	13
	Decision on different green material and equipment	4.07	12
	Imported green material or equipment	3.97	17
<b>Labor-related</b>	Resistance to change from their traditional practices	3.60	23
	Lack of the technical skill regarding green technologies and techniques	3.37	26
	Workers' unaware of the correct methods and procedures	3.50	25
<b>External</b>	Government policy	3.87	19
	Lengthy BCA approval process for new technologies	3.10	31
	More time required for TOP due to green mark certification process by BCA	3.07	32
	<b>Unforeseen circumstances in green project</b>	<b>4.20</b>	<b>8</b>

“**Longer time required during the pre-construction process: planning-related**” yielded the highest mean score of 4.57, indicating that it is the most frequently encountered challenge. The interviewees from this study verified that the pre-construction period of a green construction project usually requires more time as compared to traditional construction projects. The reason is due to the need for a more detailed and comprehensive design plan which incorporates all the green features required by the construction project. This often means more involvement and interaction with different stakeholder groups, which may also slow down the pre-construction process. The interviewees emphasized the importance that during the design development stage, the design team needs more time to study the design system performance against the stated green building goals. Most green technologies are

relatively new to the construction industry and their system performance is not well-known. Furthermore, greater efforts are needed to ensure that the green features that are incorporated into the design consider sources for cheaper, but still efficient green options.

Next, **“Difficulty in the selection of subcontractors in providing green construction service: project-related”** had the second highest mean of 4.50. Selection of subcontractors for traditional construction projects may be less difficult for experienced project managers who are familiar with the performance of subcontractors with whom they have worked in the past. It is also likely that there is insufficient performance information for subcontractors who are involved in green construction projects. As a result, the selection process becomes tougher and may take more time.

In terms of material and equipment-related challenges, the respondents cited **“Uncertainties with green material and equipment: Material & equipment-related”** as the third relevant challenge that they faced. All interviewees expressed concern over the reliability of green materials and equipment as most of these new technologies do not have a proven track record. Also, the fourth highest challenge was cited as **“High cost in green material and equipment: Material & equipment-related”**. Research done by Zhang et al. (2011) argued that using green materials would cost from 3 to 4% more than conventional construction materials. Selection of the green materials has to be cost-conscious in order to prevent budget overruns. Unlike conventional construction materials, the availability of many green materials may not be available locally. Problems arising from imported material may include understanding the legal regulations of the various countries. Furthermore, to ensure that an imported material will be compatible for local use, extensive testing may be required.

Lastly, the analysis revealed that **“Frequent meetings with green specialists: Project team-related”** is the fifth most critical challenges faced by project managers. An interviewee confirmed that there are an increased number of meetings required for a green construction project because an intense alliance with green specialists is necessary to fine-tune emergent issues.

## **4.2 Knowledge Areas & Skills Responding to the Challenges**

Based on the analysis results summarized in Table 3, this section discusses knowledge and skill areas that project managers need in order to effectively deal with the challenges of green construction.

### **Knowledge Areas and Skills for the Planning-Related Challenges**

As shown in Table 3, the survey responses revealed that the top three knowledge areas critical to project planning-related challenges are: (1) schedule management and planning; (2) communication management; and (3) risk management. As discussed, more time is usually required during the pre-project planning process for green projects. Therefore, project managers must be effective at schedule and planning management to ensure that the project will be completed in time.

**Table 3: Knowledge Areas & Skills Responding to the Challenges**

Knowledge Areas / Skills		Category of Challenges													
		Planning-related		Project-related		Client-related		Project team-related		Material & equipment-related		Labor-related		External	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
<b>Knowledge Areas</b>	Schedule management & planning	4.37	1	4.53	1	4.17	5	3.17	9	3.00	9	3.53	3	4.00	1
	Health and safety management	3.93	5	4.07	4	3.60	7	3.23	8	3.50	6	2.80	7	2.70	7
	Human resources management	3.60	8	3.60	9	3.53	9	3.53	5	3.37	8	4.40	1	3.07	5
	Stakeholder management	3.80	7	3.87	7	4.37	1	4.03	3	3.83	4	3.23	6	3.23	4
	Cost management	3.83	6	4.30	3	4.23	2	3.43	6	4.67	1	2.67	8	2.60	8
	Communication management	4.27	2	3.87	6	4.20	3	4.30	1	3.53	5	4.00	2	3.63	2
	Conflict and dispute management	4.03	4	3.93	5	3.73	6	4.17	2	3.43	7	3.53	4	2.83	6
	Risk management	4.17	3	4.33	2	4.20	4	4.03	4	4.03	3	3.50	5	3.50	3
	Materials resources management	3.57	9	3.70	8	3.57	8	3.23	7	4.40	2	2.43	10	2.47	10
	Claims management	3.13	10	3.23	10	3.27	10	2.90	10	2.87	10	2.67	9	2.60	9
<b>Skills</b>	Delegation	4.37	2	4.47	2	3.93	5	3.60	8	3.73	5	4.40	1	2.83	8
	Leadership	3.67	8	3.77	7	4.23	2	3.93	3	3.40	6	4.07	2	3.07	5
	Decision making	4.33	5	4.53	1	3.83	6	3.83	6	4.30	1	3.07	7	3.30	3
	Problem solving	4.37	4	4.33	3	4.17	3	3.73	7	3.83	3	3.17	6	4.10	1
	Team working	4.20	6	4.10	6	3.77	8	4.27	1	2.87	7	3.47	3	2.87	7
	Analytical	4.50	1	4.33	4	4.50	1	3.53	9	4.07	2	3.00	8	3.50	2
	Presentation	3.50	9	3.07	10	3.17	10	3.23	10	2.30	9	2.23	10	2.10	10
	Human behavior	3.33	10	3.57	8	3.80	7	3.87	4	2.50	8	3.33	4	3.03	6
	Negotiation	4.37	3	4.20	5	4.17	4	4.10	2	3.77	4	3.23	5	3.20	4
	Chairing meetings	3.70	7	3.47	9	3.27	9	3.83	5	2.30	10	2.37	9	2.27	9

Communication management is also important as project managers have to ensure that information is communicated effectively to all the various parties involved in the pre-project process including green specialists and architects. Analytical skill was found to be the most important skill required to address pre-project related challenges, as shown in Table 3. An interviewee mentioned that it is crucial for the project managers to analyze the whole situation and come up with an integrated project schedule that is achievable and manageable.

### **Knowledge Areas and Skills for the Project-Related Challenges**

For project-related challenges, the respondents ranked schedule management and planning as the most important knowledge area, followed by risk management. Project managers have to be aware of the risks involved in selection of a new subcontractor. As a longer risk assessment and decision-making process as well as additions and alterations to the construction scope may also affect the planned project schedule, project managers need to be equipped with good schedule and planning knowledge to cope with these challenges. The most important skill to manage the challenges was found to be decision-making, which implies that there is the need for project managers to make the best possible decision on the selection of specific technologies, systems and subcontractors required for green projects.

### **Knowledge Areas and Skills for the Project-Team Related Challenges**

Knowledge of communication management was ranked first with a mean of 4.30. Since green projects require a more holistic and integrated approach, the design process is more complex and the design phases often overlap with construction (Glavinich, 2008). Some of the interviewees reported the need for everyone in the project team to be well-informed with the project's goals and objectives in order to prevent errors. Conflict and dispute management was ranked second, as shown in Table 5. Conflict with other project team members may be unavoidable and project managers must be equipped to effectively manage conflict without affecting the progress of the project.

The survey results identified team work as the most important skill in this category (Table 6). Since challenges in this category are related to the project team, it is reasonable that project managers who are equipped with good team building skills could enhance team cohesiveness, improving the overall team performance.

### **Knowledge Areas and Skills for the Material and Equipment-Related Challenges**

Based on Table 3, knowledge of cost management, (Mean = 4.67), was ranked first for dealing with material and equipment-related challenges, followed by material resources management, (Mean = 4.40), and risk management, (Mean = 4.03). It is crucial for project managers to have a good understanding of cost management in order to effectively manage costly green materials and to prevent cost overruns. One of the interviewees pointed out that to ensure that costs stay within budget, cost estimates should be as close to the actual sum as possible during the project planning stage. Project managers have to quantify the costs and benefits of using green materials, despite market uncertainties, and assess the risk

involved in their acquisition. One interviewee reported an example of this cost versus risk decision. The employment of an innovative product could yield a high Green Mark score, but at the same time posed a high risk of product failure because it lacked a proven track record. In fact, Table 3 shows that the decision-making skill is the most critical to effectively mitigate material and equipment-related challenges. Effective decision making also implies making the right choice within the shortest time to prevent delays.

## 5. Conclusions and Recommendations

This study aimed: (1) to discover the challenges that project managers encounter in managing green construction projects; and (2) to determine critical knowledge areas and skills that can respond to the challenges. The analysis of the responses from the survey and the interviews revealed the top five challenges which are critical to project managers in managing green construction projects, include: (1) the longer time required during the pre-construction process; (2) difficulty in the selection of subcontractors who provide green construction services; (3) uncertainty with green materials and equipment; (4) the high cost of green materials and equipment; and (5) frequent meetings with green consultants and engineers. Critical knowledge areas and skills that are essential to respond to the challenges were also identified. The most important knowledge areas were schedule management and planning, stakeholder management, communication management, cost management, and human resources management. In addition, the most important skills that are required to mitigate the challenges were analytical, decision-making, team working, delegation, and problem-solving skills.

Through the findings from this study, the construction industry may gain an understanding of the attributes of a competent project manager in relation to green construction projects. In addition, the importance level of the attributes could serve as a guide to companies and learning institutions for developing training syllabi that target and focus on the more critical attributes. For future studies, it would be of interest to identify attributes that are required for a project manager from the perspective of other stakeholders such as clients, developers, government associations and construction contractors. With different perspectives, future studies could develop a competency framework. Also, it is recommended to carry out further studies on how to improve and strengthen the critical knowledge areas and skills identified in this study. By doing so, project managers can improve their competency in managing green construction projects, increasing the probability of producing successful green construction projects.

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