
EXPLORING COMPETENCIES FOR GREEN BUILDING PROJECT MANAGER

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Abstract

Sustainability concept has grown in recognition and importance since the last 10 to 15 years and the issues of achieving sustainability, climate change as well as environmental protection have been addressed by the construction players. While many studies have examined the competency of project managers, there is little attention given for green building construction. Therefore, this study aims at identifying a list of competencies for green building project manager. Through literature review, a total of 49 competencies have been identified from previous studies and this search is limited with the year of published article ranging from 2000 to 2015 using Google Scholar, which were then analysed using content analysis. This study can help in creating further knowledge and skills for project managers to be more relevant and effectively execute sustainable projects.

Keywords: *Sustainability; Competency; Project Manager; Project Management; Knowledge and Skill; Green Building.*

1.0 INTRODUCTION

Sustainability concept has gained its recognition and importance since the last 10 to 15 years (Silvius *et al.*, 2012) and the issue of achieving sustainability, climate change together with environmental protection have been addressed by the construction players either researchers or practitioners. This consciousness arise when construction gave many environmental issues such as atmospheric and water pollution (Pasquire, 1999). Apart from that, Perez-Lombard, Ortiz and Pout (2008) mentioned that both commercial and residential building are responsible for between 20% and 40% of the world's energy consumption, which are steadily rising every year. Besides consuming a large amount of energy, these buildings are also the culprits behind substantial carbon dioxide emissions, which can be detrimental to the environment and play a huge role in the world's climate change (Yudelson, 2007). Taking this as evident, construction of the buildings may result in environmental burden. Green concept and

measures have been taken by building construction industries into their planning to mitigate the harms imposed on the environment. Thus, the green building (GB) concept was introduced. As discussed in most literature, GB has many benefits to its owner, occupants as well as the environment. However, a few researches conducted clarify that there is a well-known gap between predicted and actual performance of green building (Huat & Akasah, 2011; Ng & Akasah, 2013) as there are many project managers and teams refuse to accept changing to sustainable/green project management practices from conventional practices used for decades (Sharif, Kamaruzzaman, & Pitt, 2014). Therefore, a competent project manager should be appointed by the organisation to maintain all these benefits since he or she has a direct influence over 34-47% project success. This paper seeks to answer the questions on what are the competencies of green building project manager and to present some ideas for further studies on competency of green building project manager. This paper is organised as follows.

First, it introduces the definition and meaning of green building. This is followed by the explanation on the competency concept and its theory. Then, the overview of a project manager is presented. Then, the methodology adapted for this study is demonstrated. Subsequent section presents the data analysis as well as the findings. Meanwhile, the final section concludes the article, summarises and suggests a way forward regarding this topic.

2.0 GREEN BUILDING

There is no single, widely accepted definition for GB (Robichaud & Anantatmula, 2010). Nonetheless, it was revealed by many common threads reflecting GB as a philosophy and associated project as well as construction management practices that seek to: (1) minimise or eliminate impacts on the environment, natural resources and non-renewable energy sources to promote the sustainability of the built environment; (2) enhance health, wellbeing and productivity of occupants and the whole communities; (3) cultivate economic development and financial returns for developers and whole communities; and (4) apply life cycle approaches to community planning and development. As described by Kubba (2010), Wedding (2008) and Richard (2008), GB is a building designed, constructed and operated to be resource-efficient. Meanwhile, Zhang (2013) defined GB as a structure using process that is environmentally responsible and resource-efficient throughout a building's life cycle from siting to design, construction, operation, maintenance, renovation and demolition. Furthermore, Glavinich (2008) presented that GB's terminology according to American Society of Testing Materials (ASTM) is a building that provides specified building performance requirements while minimising disturbance and improving the functioning of local, regional and global ecosystems both during and after construction and specified service life. Although there are multiple definitions, GB is actually referred to a resource-efficient building with minimal interference to the environment and is often mentioned interchangeably with sustainable construction (Hwang & Tan, 2012) and green

construction or sustainable building (Zhang, 2013). Therefore, the GB term used in this reflects the sustainable or green constructions and/or sustainable building.

Main motivational factor behind the GB construction is to minimise the negative impacts of building construction toward natural environment and provide healthier place for occupants that is cost-efficient over the life cycle than conventional structures (Doyle *et al.*, 2009). In order to persuade developers, clients and other construction parties to build GB, the GB benefits should be revealed. GB offers reducing energy and water consumption as well as maintenance, legal and insurance costs, janitorial expenses, trash collection and supplies costs (Kansal & Kadambari, 2010; Keeping & Shiers, 1996; Nalewaik & Venters, 2010; Shiers, 2000). Other than that, GB provides market advantage in increasing sale price and value (Bowman & Wills, 2008; CBRE, 2009; Pitts & Jackson, 2008), higher rental (CBRE, 2009; Chappell & Corps, 2009; Eichholtz, Kok, & Quigley, 2010), lower absenteeism and better productivity of workforce (USGBC, 2003), healthier to be used (Edwards, 2003; USGBC, 2003), enhance the sense of wellbeing (Edwards, 2003) and improve company images (Edwards, 2003; McKee, 2003).

Despite the benefits of GB, there are many barriers found from previous studies such as high initial cost (Ahn & Pearce, 2007; Bond, 2011; CBRE, 2009; Hayles & Kooloos, 2010; Hwang & Tan, 2012; Kats, Alevantis, & Capital, 2003; Kats & Capital, 2003; McKee, 2003; Pearce, 2008; Richardson & Lynes, 2007; Winter, 2004), lack of interest from clients including owners and developers (Landman, 1999), lack of training/education in sustainable design and construction (Brown, 2006; Landman, 1999), recovery of long term savings is not reflected in service fee structure, lack of technical understanding on the part of subcontractors, low level of innovation among construction professionals (Richardson & Lynes, 2007), high tendency to maintain current practices and resist change in the construction industry (Brown, 2006; Landman, 1999), unfamiliarity of green products, limited supply of green products, high cost of green products and lack of trust in untried or unproven quality of green materials and products (Brown, 2006; Hayles & Kooloos, 2010;

Landman, 1999; Richardson & Lynes, 2007). According to Korkmaz, Riley, and Horman (2010) and Enache-Pommer and Horman (2009), these barriers occur because GB is quite new with many complex processes. On top of that, there are lots of participant in the construction industry who have no clear ideas to effectively and efficiently manage GB projects. In order to maximise the project's success consistently, an organisation should recruit, develop, maintain and preserve superior project managers (Hwang & Ng, 2013) so that the project can be completed within established time and cost limitation according to the planning, scheduling and controlling as well as the responsibility held by project managers (Sears, Sears, & Clough, 2010). Thus, one of the solutions is to appoint a competent project manager in managing green or sustainable building construction (Hwang & Ng, 2013; Lippaiová & Sebestyén, 2006; Robichaud & Anantatmula, 2010; Sharif *et al.*, 2014).

3.0 COMPETENCY CONCEPT AND THEORY

The competency concept was first introduced by Federick W. Taylor in the early 20th century, followed by studies by McClelland (1973), Boyatzis (1982) as well as Spencer and Spencer (1993). After that, it grows into an intention among researchers especially in the US. Studies on competency have been also conducted by various researchers from multi-disciplines with human resource management discipline being the most active discipline in studies related to competency (Mohd Derus, Karim, & Qusoiri, 2008). According to Parry (1996), competency is defined as a collection of knowledge, skills and attribute that influences individual performance. Competency is also referred to motive, personal characteristic, skill and ability shown through consistent behaviour (Fleisher, 2003; Perdue, Woods, & Ninemeier, 2001). Meanwhile, Blancero, Boroski, and Dyer (1996) defined competency as knowledge, skills, ability and other characteristics demonstrating the desired behaviour in the future. On top of that, it was also defined by Ulrich, Brockbank, Yeung, and Lake (1995), which lays into individual knowledge,

skills and ability. Mansfield (1996) mentioned that competency is a series of skills and traits needed by workers to do their work effectively. According to McLagan (1996), competency consists of knowledge and skills that underlie effective performance. On the other hand, Mirabile (1997) suggests that core competencies are related to skill, ability or characteristic with a relationship or influence on highly performance works. Rothwell, Sanders and Soper (1999) also defined competency as a field of knowledge or skills required in producing identified output. Output in this context refers to the product or services that fulfil the need of human resources development towards organisation. In the study of Rifkin, Fineman and Ruhnke (1999), the easiest way to understand competency is by referring it to anything that is required by a person to do a job perfectly. Competence is also defined by Holmes and Joyce (1993) as an action, behaviour or results exhibited by individuals that is linked with the ability to transfer skills and knowledge to new situations within his or her career. Within this definition, Meyer and Semark (1996) added "trait" and "value orientation" when they describe the meaning of competency. Moreover, Hammersley and Tynon (1998) defined the definition of competency from "The Council on Hotel, Restaurant and Institutional Education" as an ability to implement activities within the scope of works. According to Klein (1996), core competencies are the behaviour of individuals who consistently demonstrate superiority over ordinary performers. Apart from that, Bonder, Hollands, and Miles (1999) stated that core competencies are any knowledge, skills, abilities or personal qualities expressed through behaviour that can result in excellence in a service.

In addition, the competency is often associated with the Iceberg Theory introduced by Spencer and Spencer (1993). In this theory, the competency is described as an iceberg at the sea level, which is divided into two parts namely the visible part and hidden part. The visible part of the iceberg represents knowledge and skill. Meanwhile, the hidden part represents interpersonal, motive/trait/concept and value/moral. Figure 1 illustrates the Iceberg Theory.

Table 1: Ideas in defining competency

No	Author (Year)	Ability	Motive	Traits	Knowledge	Skills	Image	Behaviour	Others
1	Boyatzis (1982)	X	X	X	X	X	X	X	X
2	Holmes and Joyce (1993)	X			X	X			
3	Spencer and Spencer (1993)	X	X	X	X	X	X	X	X
4	Ulrich <i>et al.</i> (1995)	X			X	X			
5	Parry (1996)				X	X		X	
6	Blancero <i>et al.</i> (1996)	X			X	X			X
7	Mansfield (1996)			X		X			
8	McLagan (1996)				X	X			
9	Meyer and Semark (1996)	X		X	X	X			
10	Mirabile (1997)	X		X	X	X			
11	Hammersley and Tynon (1998)	X							
12	Rothwell <i>et al.</i> (1999)				X	X			
13	Perdue <i>et al.</i> (2001)	X	X	X		X			
14	Fleisher (2003)	X	X	X		X			
15	Bonder <i>et al.</i> (1999)	X			X	X			

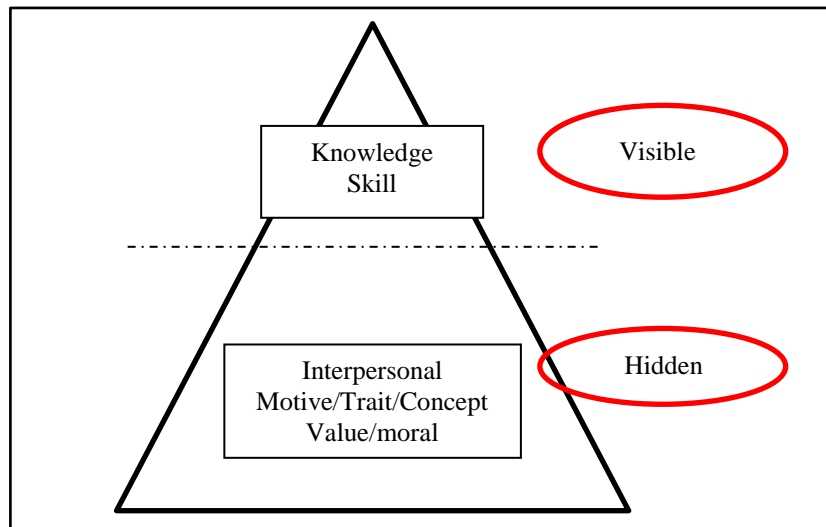


Figure 1: Iceberg Theory by Spencer and Spencer (1993)

Although there are various definitions found, 'competency' in this paper only refers to skills and knowledge, which is the visible part of the iceberg since it is easy to be formed compared to hidden part (Sail, 2010). Knowledge is awareness, information, or understanding about facts, rules, principles, guidelines, concepts, theories, or processes needed to successfully perform a task (Marrelli, 2001; Mirabile, 1997). Knowledge can be concrete, specific and easily measurable, or can be more complex, abstract and difficult to be assessed (Lucia & Lepsinger, 1999). A skill is a capacity to perform mental or physical tasks with a specified outcome (Marrelli, 1998). Similar to knowledge, skills can range from highly concrete and easily identifiable tasks such as filing documents alphabetically to those that are less tangible and more abstract such as managing a quality improvement project (Hoge, Tondora, & Marrelli, 2005; Lucia & Lepsinger, 1999).

4.0 PROJECT MANAGER'S COMPETENCIES

Project manager is an individual with the responsibility to ensure the flow of a project from planning, constructing and getting the approval for each construction project (Meredith & Mantel, 1989). Among the construction parties, project manager is important and vital to project success (Hwang & Ng, 2013) and has direct influence over 34-47% of project success (Toney, 2001). According to Sharif *et al.* (2014), there will be no project without project manager. Many researchers mentioned the importance of a competent project manager to the success of a project (Baker, Fisher, & Murphy, 1983; Belassi & Tukel, 1996; Locke, 1984; Salleh, 2009; Sayles & Chandler, 1971; Turner & Zolin, 2012) with several researchers such as Avots (1969), Belassi and Tukel (1996), Crawford (2001) as well as Sayles and Chandler (1971) emphasizing on project manager's critical skills through their studies. Parallel with the findings from Ahadzie (2007), there are growing awareness among industries on the relationship between reaching project success and the competencies of construction project management. Now, successful construction organizations are

focusing on ensuring that the project manager possesses the core competencies required to fulfil their assignments in achieving customers' satisfaction. It is believed that project managers play a crucial role in completing a project.

With the aim to manage projects accordingly, a project manager should acquire several skills and knowledge. Many published studies have identified that managerial skills such as social skills, decision-making skills, problem handling skills, the skill to recognize opportunities and manage changes are necessary for efficient project performance as the key personal attributes affecting project success (Fryer, 1985). Project Management PMI (2008) has highlighted essential knowledge that project managers should possess, which are schedule management and planning, cost management, quality management, human resource management, risk management, supply chain management and communication management.

As industry changes, project managers find themselves confronted by new issues and roles as part of their responsibility (Edum-Fotwe & McCaffer, 2000). Many project managers and project teams are having difficulties in adapting new practices, thus refused to accept changes in sustainable or green project management practices from conventional practices that have been used for decades (Sharif *et al.*, 2014). Hence, there is a need in understanding the pivotal attributes that should be possessed by project manager to manage green construction projects (Hwang & Ng, 2013). In order to deliver GB project successfully according to client's cost expectation, a competent project manager is needed (Robichaud & Anantatmula, 2010). Although there is a standard addressed for project management, the role of project managers in realizing sustainable development is poorly stated with their lack of competencies to consider the sustainability aspects of their projects (Silvius & Schipper, 2014). Similarly in Malaysia, project manager and project team are among the key factors contributing to the success of green building project implementation (Sharif *et al.*, 2014).

5.0 METHODOLOGY

To gain an in-depth understanding on the various competencies for green building's project manager directly or indirectly identified by other researchers, content analysis was used as an appropriate analysis approach of this study. Content analysis is a method of analysing written, verbal or visual communication messages (Cole, 1988), which was first used as a method for analysing hymns, newspaper and magazine articles, advertisements and political speeches in the 19th century (Harwood & Garry, 2003). As recommended by Silverman (2013), it is the most common technique utilised to analyse texts. Content analysis is divided into two categories, which are 'inductive content analyses and 'deductive content analyses. Thus, this paper has selected 'deductive content analysis' for the published research papers on the current subject and area since the researcher decided to retest existing data in the new context as suggested by Catanzaro (1988).

Other than that, 'deductive content analysis' is generally based on earlier works such as theories, models, mind maps and literature reviews (Hsieh & Shannon, 2005; Polit & Beck, 2004; Sandelowski, 1993). A total of 648 papers were found during literature search using Google Scholar published between the year 2000 and 2015. To clarify the suitable published paper for this study, a search strategy using keywords offered by authors through their previous study during preliminary literature review was done. The keywords used are *green_building AND project_manager AND competencies OR competence OR competency*. From these selected papers, a total of 75 abstracts were further reviewed concerning the identification of competencies for GB project manager. This has resulted in the exclusion of 53 publications, leaving 22 publications. All the competencies from these 22 papers were recorded in Table 2.

Table 2: Publications in relation to competencies for GB's project manager

Author	Title	Competencies	
		Knowledge	Skills
Hwang and Ng (2013)	Project Management Knowledge and Skills for Green Construction	<ul style="list-style-type: none"> • Cost management • Communication management • Schedule management and planning • Health and safety management • Risk management • Conflict and dispute managements • Stakeholder management • Material resource management • Claim management • Human resource management 	<ul style="list-style-type: none"> • Decision making • Delegation • Analytical • Team working • Problem solving • Leadership • Negotiation • Human behaviour • Chairing meeting • Presentation
Lam <i>et al.</i> (2009)	Factors Affecting the Implementation of Green Specifications in Construction	<ul style="list-style-type: none"> • Green specifications 	
Riley, Pexton, and Drilling (2003)	Procurement of Sustainable Construction Services in the United States: the Contractor's Role in Green Buildings	<ul style="list-style-type: none"> • Estimation • Green building materials • Waste minimisation and recycling • Indoor air quality management 	
Robichaud and Anantatmula (2010)	Greening Project Management Practices for Sustainable Construction	<ul style="list-style-type: none"> • Sustainable building practices • LEED requirement • Sustainability goals • Familiarity with product type and market • Pricing and developing cost-saving strategies 	<ul style="list-style-type: none"> • Planning and strategy meeting • Communication and document sharing • Communication • Teamwork

		<ul style="list-style-type: none"> • Procuring specialised software for sustainable project • Budgeting and scheduling 	
Li <i>et al.</i> (2013)	Project Management Factors Affecting Green Building Projects: Case Study of Singapore		<ul style="list-style-type: none"> • Communication • Leadership • Problem solving
Hwang, Leong, and Huh (2013)	Sustainable Green Construction Management: Schedule Performance and Improvement	<ul style="list-style-type: none"> • Planning and scheduling • Familiarity with green technologies 	
Hojem, Sørensen, and Lagesen (2014)	Designing a 'Green' Building: Expanding Ambitions through Social Learning	<ul style="list-style-type: none"> • Green design • Green building contract (requirement) 	
Senaratne and Hewamanage (2015)	The role of Team Leadership in Achieving LEED Certification in a Green Building Project		<ul style="list-style-type: none"> • Leadership (proactive planning and visualization, collective implementation, teamwork, and continuous learning and knowledge sharing)
Wang <i>et al.</i> (2015)	Critical Factors for Sustainable Project Management in Public Projects	<ul style="list-style-type: none"> • Process control (risk management) • Resource management • Stakeholder management • Team management • Objective management • Information management 	<ul style="list-style-type: none"> • Leadership • Communication • Evaluation • Project result • Innovation
Sim and Putuhena (2015)	Green Building Technology Initiatives to Achieve Construction Quality and Environmental Sustainability in the Construction Industry in Malaysia		<ul style="list-style-type: none"> • Holistic thinking • Decision making
Goedknegt (2012)	Sustainability in Project Management: A case study at University of Applied Sciences Utrecht		<ul style="list-style-type: none"> • Decision making
Son <i>et al.</i> (2011)	Implementing Sustainable Development in the Construction Industry: Constructors' Perspectives in the US and Korea	<ul style="list-style-type: none"> • Sustainable material • Water efficiency • Site management • Sustainable procurement 	
Elforgani and Rahmat (2010)	An Investigation of Factors Influencing Design Team Attributes in Green Buildings	<ul style="list-style-type: none"> • Green design • Life cycle assessment 	
Fortunato III, Hallowell, Behm, and Dewlaney (2011)	Identification of Safety Risks for High-Performance Sustainable Construction Projects	<ul style="list-style-type: none"> • Sustainable standards (LEED) • Safety and health management 	
Lapinski, Horman, and Riley (2006)	Lean Processes for Sustainable Project Delivery	<ul style="list-style-type: none"> • Environmental • Sustainable objectives • Budgeting • Sustainable material 	<ul style="list-style-type: none"> • Teamwork
Shi <i>et al.</i> (2014)	Improving the Competence of Construction Management Consultants to Underpin Sustainable Construction in China	<ul style="list-style-type: none"> • Construction cost planning and control • Civil engineering and construction • Engineering contract and law 	<ul style="list-style-type: none"> • Onsite practical skill • Personnel quality • Continuing professional learning

		<ul style="list-style-type: none"> • Construction project management 	
Marcelino-Sádaba <i>et al.</i> (2015)	Using Project Management as a Way to Sustainability. From a Comprehensive Review to a Framework Definition	<ul style="list-style-type: none"> • Sustainable tool 	<ul style="list-style-type: none"> • Ethics
Isa, Alias, and Abdul Samad (2014)	Sustainability Integration into Building Projects: Malaysian Construction Stakeholders' Perspectives	<ul style="list-style-type: none"> • Sustainable integration planning 	
Ahn <i>et al.</i> (2013)	Drivers and Barriers of Sustainable Design and Construction: The Perception of Green Building Experience	<ul style="list-style-type: none"> • Sustainable practices • Sustainable design and construction • Energy-related strategies and technologies 	
Elforqani, Alnawawi, and Rahmat (2006)	The Association between Client Qualities and Design Team Attributes of Green Building Projects	<ul style="list-style-type: none"> • Environmental assessment • Green designs 	
Lippaiová and Sebestyén (2006)	Green Construction Project Management	<ul style="list-style-type: none"> • Risk management • Green goals and objectives 	<ul style="list-style-type: none"> • Communication • Decision making
Hwang and Tan (2012)	Green Building Project Management: Obstacles and Solutions for Sustainable Development	<ul style="list-style-type: none"> • High performance green building delivery system • Green requirement 	<ul style="list-style-type: none"> • Selection of team members

6.0 ANALYSIS FOR GREEN BUILDING PROJECT MANAGER'S COMPETENCY

As mentioned before, competency is referred to knowledge, skills or ability to deliver tasks or assignments successfully. Thus, these findings demonstrated the above definitions that were categorised into knowledge and skill. Overall, 28

knowledge and 21 skills were identified as the findings of this study, which are believed to be reflected as the competencies for green building project manager. Figure 2 demonstrates the research findings together with the further explanation on each competency in Table 3 and Table 4.

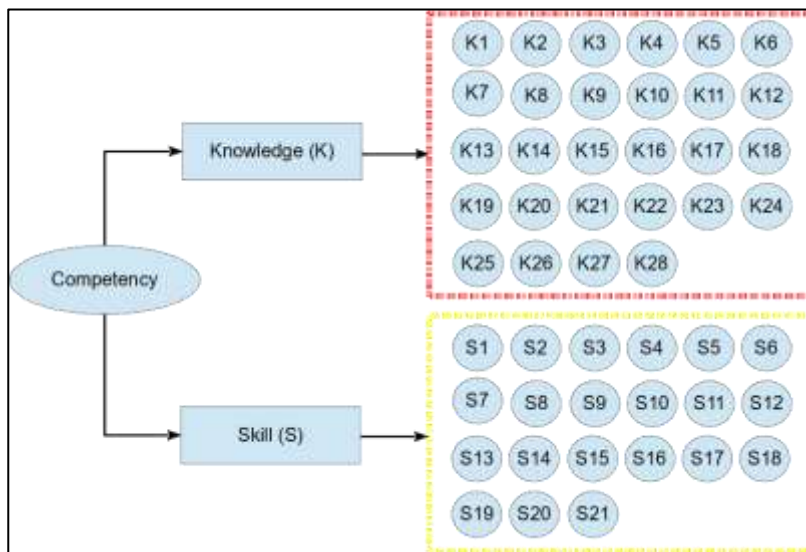


Figure 2: Proposed Competencies for Green Building Project Manager

Table 3: Explanation on Knowledge for GB's project manager

Code	Knowledge	Description	Author	Frequency
K1	Planning and scheduling	Knowledge on intensive construction planning and scheduling is one of the distinctive characteristics in GB construction and green requirements need to be well addressed and reflected in executing plans and construction schedules to avoid any impediments.	Hwang and Ng (2013), Robichaud and Anantatmula (2010), Hwang <i>et al.</i> (2013), Shi <i>et al.</i> (2014), Isa <i>et al.</i> (2014)	
K2	Green building materials management	The selection of green building material should be aligned with green building goals and objectives and can improve environmental performance.	Hwang and Ng (2013), Riley <i>et al.</i> (2003), Lam <i>et al.</i> (2009), Son <i>et al.</i> (2011), Lapinski <i>et al.</i> (2006)	5
K3	Cost management	This knowledge is amplified to provide accurate cost estimation, seek cost savings in a GB project and assist design team with pricing methods.	Hwang and Ng (2013), Riley <i>et al.</i> (2003), Robichaud and Anantatmula (2010), Lapinski <i>et al.</i> (2006)	4
K4	Sustainable standards	PM should know the sustainable/green standards to set sustainable goals/objectives in designing GB projects.	Robichaud and Anantatmula (2010), Fortunato III <i>et al.</i> (2011), Marcelino-Sádaba <i>et al.</i> (2015), Elforgani <i>et al.</i> (2006)	4
K5	Sustainable goals/objectives	PM should set sustainable goals/objectives as early as the design phase to meet environmental building performance criteria and should be explicit and measurable as general as meeting GBI rating criteria.	Robichaud and Anantatmula (2010), Lapinski <i>et al.</i> (2006), Lippaiová and Sebestyén (2006), Wang <i>et al.</i> (2015)	4
K6	Sustainable/green designs	Knowledge on designing GB to fulfil environmental criteria such as energy efficiency, water efficiency and selection of GB materials.	Hojem <i>et al.</i> (2014), Elforgani and Rahmat (2010), Elforgani <i>et al.</i> (2006), Ahn <i>et al.</i> (2013)	4
K7	Risk management	Knowledge on identifying, analysing and responding to GB project risks and it will cause a delay if risk assessment and decision making process take a long period.	Hwang and Ng (2013), Wang <i>et al.</i> (2015), Lippaiová and Sebestyén (2006)	3
K8	Green strategies	Knowledge on better building sustainability performance, lower operational cost, protection on the health of building residents and energy saving for achieving sustainability goals.	Wang <i>et al.</i> (2015), Robichaud and Anantatmula (2010), Ahn <i>et al.</i> (2013)	3
K9	Green requirement	Knowledge on requirement to build GB, which is typically found in specifications of contract documents.	Shi <i>et al.</i> (2014), Hojem <i>et al.</i> (2014), Hwang and Tan (2012)	3
K10	Health and safety management	PM need to understand the impacts of project activities on the sustainability of environment and reduce the number of accidents and accident's effects in constructing GB.	Hwang and Ng (2013), Fortunato III <i>et al.</i> (2011)	2
K11	Stakeholder management	PM should manage stakeholders in understanding their needs and objectives to deliver GB project successfully.	Hwang and Ng (2013), Wang <i>et al.</i> (2015)	2

K12	Human resource management	PM should select all parties involved in GB projects based on their knowledge in GB construction.	Hwang and Ng (2013), Wang <i>et al.</i> (2015)	2
K13	Sustainable practices	PM should perform sustainable practices during GB construction	Robichaud and Anantatmula (2010), Ahn <i>et al.</i> (2013)	2
K14	Familiarity with green products and their market	PM should be familiar with green products and their market to align with sustainability goals.	Robichaud and Anantatmula (2010), Hwang <i>et al.</i> (2013)	2
K15	Sustainable procurement	Knowledge on meeting organisation needs for goods, achieving value for money for organisation, society and economy while minimising damage to the environment.	Robichaud and Anantatmula (2010), Son <i>et al.</i> (2011)	2
K16	Sustainable construction	PM should select proper construction method that it will result in quite different outcomes in terms of sustainability	Shi <i>et al.</i> (2014), Ahn <i>et al.</i> (2013)	2
K17	Communication management	PM needs to ensure the information is delivered effectively to all parties involved in GB project to align with sustainability goals.	Hwang and Ng (2013)	1
K18	Conflict and dispute management	PM must be prepared to manage conflicts effectively without affecting GB project progress.	Hwang and Ng (2013)	1
K19	Claim management	GB construction involves many parties; thus, it is conducive for conflicts. PM should avoid it with very clear stated contractual terms, early communication and good understanding on the causes of claims.	Hwang and Ng (2013)	1
K20	Indoor air quality management	Knowledge on managing indoor air quality in GB project.	Riley <i>et al.</i> (2003)	1
K21	Team management	PM should select new members by identifying and classifying their abilities and needs, coordinating and delegating tasks based on their competency.	Wang <i>et al.</i> (2015)	1
K22	Information management	PM should know on how to record data completely using data recording mechanism (information of suppliers and experts, summarising and recording best practices, standardised document and codes).	Wang <i>et al.</i> (2015)	1
K23	Water efficiency	Knowledge on how to use water efficiently during GB construction.	Son <i>et al.</i> (2011)	1
K24	Site management	Knowledge on impacts of GB construction on soil and landfill.	Son <i>et al.</i> (2011)	1
K25	Life-cycle assessment	Knowledge on life-cycle assessment when designing GB project.	Elforгани and Rahmat (2010)	1
K26	Environmental knowledge	PM should be able to obtain environmental knowledge and adopt them as early as designing phase of GB project.	Lapinski <i>et al.</i> (2006)	1
K27	Civil engineering and construction	Knowledge on civil engineering and construction in the sustainability manners to prevent impacts of construction on environment.	Shi <i>et al.</i> (2014)	1
K28	Green building delivery system	Knowledge on how to deliver GB projects with respect to sustainability.	Hwang and Tan (2012)	1

Table 4: Explanation on Skills for GB's project manager

Code	Skill	Skill	Author	Frequency
S1	Teamwork	The genuine intention to work cooperatively with others as opposed to separately or competitively is pre-requisite for influencing the team to perform in a desirable manner.	Hwang and Ng (2013), Robichaud and Anantatmula (2010), Senaratne and Hewamanage (2015), Lapinski <i>et al.</i> (2006)	4
S2	Leadership	Refers to the intention to serve as a leader of a team or other groups. Although it implies a desire to lead others and can be manifested in the form of formal authority and responsibility, effective team leadership also requires the leader to know when <i>not</i> to act authoritatively if they are to extract the best out of the team.	Hwang and Ng (2013), Li <i>et al.</i> (2013), Senaratne and Hewamanage (2015), Wang <i>et al.</i> (2015)	4
S3	Communication	PM should be able to efficiently communicate with all parties involved in GB project to fulfil sustainability goal.	Robichaud and Anantatmula (2010), Li <i>et al.</i> (2013), Wang <i>et al.</i> (2015), Lippaiová and Sebestyén (2006)	4
S4	Decision making	Ability to take appropriate actions under constraints of limited time, information and resources or use good judgement in resolving problems.	Hwang and Ng (2013), Sim and Putuhena (2015), Goedknecht (2012), Lippaiová and Sebestyén (2006)	3
S5	Analytical and holistic thinking	Refers to the need to develop understanding on a situation or problem by breaking it into components or by tracing the causes and implications of a situation in a systematic manner.	Hwang and Ng (2013), Sim and Putuhena (2015)	2
S6	Problem solving	During the process of design and construction stages, some unexpected operational and technical problems that can cause pollution may arise. PM should generate fast solutions that can greatly improve the environmental performance of building projects. Problem solving can be called troubleshooting. Therefore, effective and efficient troubleshooting is very important to successfully implement green building projects.	Hwang and Ng (2013), Li <i>et al.</i> (2013)	2
S7	Chairing meeting	This skill is under general skills. 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 his/her specialist knowledge.	Hwang and Ng (2013), Robichaud and Anantatmula (2010)	2
S8	Document and knowledge sharing	Skill on sharing document and knowledge to all GB project participants.	Robichaud and Anantatmula (2010), Senaratne and Hewamanage (2015)	2
S9	Continuous learning	This is important since constructing GB introduces many new concepts such as	Senaratne and Hewamanage (2015), Shi <i>et al.</i> (2014)	2

		lifecycle management and building information modelling that will penetrate the minds of construction practitioners. Therefore, PM should be able to keep learning new knowledge and update their knowledge structure constantly.		
S10	Delegation	Ability to effectively distribute tasks to other members of organisation or assign true decision making authority to qualified subordinates.	Hwang and Ng (2013)	1
S11	Negotiation	Negotiation skills of the project manager are called for i) Scope, cost and schedule objectives, ii) Changes to scope, cost or schedule, iii) Contract terms and conditions, iv) Resource availability and utilisation.	Hwang and Ng (2013)	1
S12	Human behaviour	Project manager has to see general functions associated with the project. These include managing human systems, logistics, information flows and organisational relationships.	Hwang and Ng (2013)	1
S13	Presentation	PM should be able to present all information (and related to GB) understandably to all project participants.	Hwang and Ng (2013)	1
S14	Proactive planning and visualisation	PM should be able to predict and visualise one step ahead in managing GB project.	Senaratne and Hewamanage (2015)	1
S15	Collective implementation	Skill on interdependency, good communication and client facilitation.	Senaratne and Hewamanage (2015)	1
S16	Evaluation	PM should be able to evaluate all circumstances in GB project construction.	Wang <i>et al.</i> (2015)	1
S17	Innovation	PM should be innovative since GB projects acquire new technologies and use different materials.	Wang <i>et al.</i> (2015)	1
S18	Onsite practical skill	Information and technology skills, learning skills and application skills	Shi <i>et al.</i> (2014)	1
S19	Personnel quality	Consists of teamwork potential, creativity, ownership, management and delivery of solutions to clients, interpersonal communication skills and organisation skills.	Shi <i>et al.</i> (2014)	1
S20	Ethics	Ability to analyse both the project results and processes under classic ethic perspectives (Virtue, ethics/utilitarianism, deontology/social contract).	Marcelino-Sádaba <i>et al.</i> (2015)	1
S21	Select team member	PM should select team members based on their knowledge or understanding on GB.	Hwang and Tan (2012)	1

7.0 CONCLUSION AND RECOMMENDATION

From the present review of literature, 49 important competencies consisting 28 knowledge: planning and scheduling, green building materials management, cost

management, sustainable standards, sustainable goal/objective, sustainable/green design, risk management, green strategy, green requirement, health and safety management, stakeholder management, human resource management, sustainable practices, familiarity with green products and their market, sustainable

procurement, sustainable construction, communication management, conflict and dispute management, claims management, indoor air quality management, team management and information management, water efficiency, site management, life cycle assessment, environmental knowledge, civil engineering and construction and green building delivery system along with 21 skills known as teamwork, leadership, communication, decision making, analytical thinking, problem solving, chairing meeting, document and knowledge sharing, continuous learning, delegation, negotiation, human behaviour, presentation, proactive planning and visualisation, collective implementation, evaluation, innovation, onsite practical skill, personnel quality, ethics and selection of team members were identified.

However, the findings of this study are dissimilar to previous studies related to the identification of competencies for GB project manager that identified different number of competencies as well as some other competencies that were not found in the present outcomes. This inconsistency may be due to several reasons with some of them are due to:

- Different online databases subscribed
- Limitation of the research methodology adopted in the study
- Limitation of year published between 2000 and 2015

After going through all 22 studies, it was found that two studies were conducted in Singapore (limited to the Project Management Book of Knowledge (PMBOK) and differentiated the knowledge and skill between traditional building and green building) and Netherlands (focusing on literature from “Education for Sustainable” field) only. This study is also in line with several writers’ suggestions (in Hwang and Ng (2013), Marcelino-Sádaba, González-Jaen, and Pérez-Ezcurdia (2015) and Hamid *et al.* (2012)) to provide new knowledge and skill areas that are not included in their study to further nourish the existing body of knowledge for managing green construction projects. These competencies may be vary from country to country depending on the evolution of GB in the respective country.

For future studies, it would be interesting to identify the critical competencies of project manager for managing GB projects and how these competencies will influence the successful of the GB project. Besides, it is beneficial if the study can be done on how to improve and strengthen the competencies identified by this study. In addition, establishing training module for each competency will give benefits to project managers to improve their competency in managing green construction projects as well as increasing the probability of producing a successful green construction project in the future.

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