INTELLIGENT GREEN BUILDING PROJECTS: EXPLORING THE ROLE OF PROJECT MANAGEMENT

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The role of built environment in generating economic activity is well established. Yet the negative effects produced by construction and operation of built environment on the sustainability of limited earthly lifesupport systems remains a matter of continued concern for academia and practice. Construction of intelligent green buildings has attracted considerable interest over the past decade. These buildings are not only expected to provide an enhanced living experience to their occupants but also meet the needs of sustainability. While some research has been done on different aspects of construction process of intelligent green buildings, yet the role of project management in facilitating the success of these projects has received little research attention.

This study attempts to fill this gap in knowledge and draw upon literature to propose a framework for project management of intelligent green building projects. The framework consists of four key dimensions: processes, people, methods and knowledge; which are further divided into various sub-elements. The proposed framework is expected to provide project managers a structured knowledge on the skills, expertise, attitudes, decision making processes, control mechanisms and effective delivery of these projects. Theoretically, the study builds knowledge on project management approach needed for intelligent green building projects. The study will help in identifying gaps in availability of project management tools, techniques and processes that may be needed specifically for accomplishing intelligent green building projects. The research offers opportunities for exploring how project management can be leveraged to achieve success in intelligent green building. Limitations of the study are noted.

Key words:

Intelligent green buildings, role of project management, project team skills, project management processes, project management tools and techniques

INTRODUCTION

The construction and operation of built environment produces significant effects on the sustainability of limited earthly life-support systems. An estimated 30-40% of global energy usage is associated with built environment activities (UNEP 2007). These activities include use of energy in manufacturing of building material and components, transportation to and from construction site, construction work, operation of the building, demolition and removal of waste from the site. On the other hand, built environment contributes 10-15% of world gross domestic product (GDP) and generates jobs in a number of sectors including manufacturing, operations and services (UNEP 2007).

While the role of built environment in generating economic activity is significant, yet its impact on sustainability of limited resources needs to be understood. Considerable research and policy formulation activities have taken place over last decade to establish sustainable agenda and initiatives at government, industry and academia levels. Constant efforts are being made to develop new concepts, technologies, systems, procedures, practices, methodologies, skills, knowledge and leadership attributes to help embrace sustainability and to desired sustainable intervention in built environment projects.

Among such developments, the concept of intelligent building, which has its origin in 1980, is receiving considerable attention lately (Derek & Clements-Croome 1997). Intelligent green buildings (IGB) symbolizes fusion of technological advancements in design, development and use of building products to achieve comfort living and 'increased occupant control of their local environment' (Wong, Li & Wang, 2005, p.143).

However, construction and operation of IGBs is a complex endeavor. It requires knowledge and experience in various aspects including technology awareness, understanding of green and sustainability principles, project management, desire and commitment to sustainability, and proactive management of construction and operation of the building (Hwang & Ng 2013).

Despite the increasing intensity of research and existence of literature (for instance, Wong, Li & Wang, 2005) related to various facets construction and operation of intelligent building, the exploration of the role of project management in IGB projects has received relatively little attention.

This research attempts to fill this gap in knowledge and conduct a systematic literature review to identify practices and knowledge that could be used for effective project management of IGB projects.

The development of project management framework for IGB projects will provide guidance to project managers, policy makers, and other stakeholders take a holistic approach to successfully deliver IGB projects.

LITERATURE REVIEW

Intelligent buildings have been defined in a variety of ways (So, Wong & Wong 1999; Wong, Li & Wang, 2005). However, no clear definition exists on what is IGB. We define intelligent green building as 'one which creates enhanced experience and well being of occupants through integration and use of technology, material and resources, sustainable practices and techniques throughout lifecycle of the building leading to minimization of building life-cycle costs and conscientiousness consumption of limited earthly resources.'

The IGB combines sustainable construction with integrated technologies to provide a number of benefits to the occupants of the buildings. These benefits include minimisation in operating costs, improved quality of work environment, improved market value, increased flexibility and enhanced work productivity (Harrison 1992, p.15; So & Wong 2002).

Given the wide range of benefits offered by intelligent green buildings, a number of studies have highlighted the infusion of technological advancements to achieve sustainable outcome of these building projects. The work of Kolokotsa et al. (2011) and Torunski et al., (2012) describe various intelligent technologies and systems that may be used to achieve best sustainable outcome of the built environment. These technologies, for instance, include Fuzzy logic control to control the indoor environment by recording and responding to user's preferences, neural networks to reduce energy consumptions, and software agents for control of smart environments.

The complexity thus not just involves what happens during the construction phase, but includes having clear understanding of the aspirations of the client, understanding of the tested and proven available technologies, materials and equipments; understanding of the contemporary project management processes and best practices that can be used to accomplish the project work from concept to delivery.

Project management is therefore seen to play a vital role towards creation of IGBs. Hwang and Ng (2013) have identified and discussed a number of skills and attributes that are required by people working on project teams to deliver IGB projects. They classified the challenges faced in project management of IGBs in seven categories, i.e. planning-related, projectrelated, client-related, project team related, material and equipment related, labor related, and external. They found that difficulties related to finding the suppliers who could supply the right green products and materials, understanding of the client's green aspirations, meetings with green or ESD consultants / experts, uncertainties with green material and equipments, resistance to adopt new construction practices, and unforeseen circumstances and risks remain some of the key challenges faced by IGB projects. Based on their data they recommended that active schedule management and planning, proactive communication management, and proper risk management could be vital for success of intelligent green projects.

We argue that an understanding of the role of project management in delivery of intelligent green projects is important as these projects need effective and proactive management from start to the end of the project work. A number of key decisions need to be made that could not only significantly influence the outcome of the projects but could also influence the users' experience of living in the created IGB products. However, little is known on the role played by the project management in achievement of IGB projects. This study intends to fill this gap in knowledge by examining the literature on IGBs in order to identify practices, knowledge, skills and experience required by project teams to accomplish these projects. To this end, the study seeks to study the following question

What role can the project management play in successful accomplishment of intelligent green building projects?

The rest of the paper is divided as follows. Next we discuss methodology used to collect data and how data was analysed. Then we create the proposed framework for project management of IGB projects. It is followed by the Conclusion, and discussion of limitation and future research direction.

METHODOLOGY

The data for this study was collected through search of the relevant literature. We performed search of three premiere databases including Google Scholar, Science Direct, and Emerald Management Xtra to identify the available literature that suited the objectives of this study. These three databases were selected as they were expected to provide a good coverage of the relevant literature. In addition, as a large number of journals are linked with Science Direct and Emerlad Management Xtra, we expected that it will help us in the search of the available literature on the subject.

We used a number of key word combinations to search the three databases. These key word combinations are listed in Table 1.

Table 1. Key-words combinations used for data collection

Key words	Key words	
"intelligent building" + "project	"intelligent building" + "project	
manager"	manager skills"	
"intelligent building" + "project	"intelligent building" + "project	
management"	management skills"	
"intelligent buildings" + "project	"Intelligent buildings" + "Project	
team skills"	skills"	
"intelligent green buildings" + "project team skills"	"intelligent buildings" + "projects"	
"intelligent buildings" + "project team"	"green buildings" + "project team skills"	

Initially we screened the database search output by reading through the abstract of the research papers. We then downloaded the relevant articles for a detailed read. This resulted in collection of twenty nine research articles.

Content analyses using qualitative analysis techniques were used to review the downloaded articles. The content analyses focussed on identifying the knowledge of processes, tools and techniques; skills, educational and professional qualifications, technological know-how, expertise, decision making capabilities, leadership and other soft-skills that may be needed for project management of IGB projects. Drawing upon the analyses, we propose a framework that describes the role of project management as discussed below.

THE PROPOSED FRAMEWORK ON THE ROLE OF PROJECT MANAGEMENT:

As stated earlier, we draw upon the review of literature to propose a framework (Table 2) on the role of project management for construction of intelligent building projects. The framework is divided in four components as below:

- (a) Processes & Control: Discuss the processes that would be needed to manage IGB projects across their life cycle.
- (b) People & Skills: Discusses the skill needs, expertise and knowledge, educational qualifications, professional accreditation requirements, attitudes and behavioural aspects of people working on the IGB projects.
- (c) Methods & Techniques: Discusses use of methodologies, best practices, and procedures to deliver IGB projects.
- (d) Knowledge sharing: The need for knowledge creation, storage and transfer among professionals working on the IGB projects.

Processes & control

Review and optimisation of current project management processes: While the current project management processes could be usefully adopted for delivering IGB projects, there is a need for refinements or changes to cater to project requirements of IGB projects. The current project management processes as described mainly by PMBOK and PRINCE2 could be used with some subtle refinements, customisation and addition of new processes in IGB projects. For instance, in the requirements gathering process and define scope process (as per PMBOK framework) one of the inputs to these processes should be IGB requirements documentations in addition to other inputs. Scoping the IGB building needs is critical to design the IGB buildings appropriately.

Control: The existing control and project performance measurement processes and techniques for delivery of IGB projects may need attention. Presently project performance and control is done through use of earned value management (EVM), forecasting, and work performance information gathering and reporting techniques. The complexity of IGB projects which involve combining various technologies and systems to facilitate intelligent interaction of users with the building, and the green features requirements may necessitate change of project control procedures and performance measurement criteria. For example, EVM analysis which solely focuses on calculating dollar amount for work accomplished may need to be refined to show the proportion of work completed for capital investment items such as purchase and integration of technologies in the building and the proportion of traditional construction work completed as against the total EVM value.

Decisions: Project management can play a vital role in achieving broadbased decision making for delivery of IGB projects. The involvement of multiple stakeholders in delivery and operation of IGB projects require that decision making process should be broad based. It is important that tenants or users, facility managers and other potential stakeholders e.g. suppliers and maintenance people should be involved in decision making process at the planning and design stages of the project to ensure their inputs are sought and translated in delivery of building. Current project management processes are driven on achieving the client aspirations; however success of intelligent green project requires a smooth interaction between the users and the building. It is therefore recommended that project management decision process be fine tuned to facilitate greater user involvement at the planning and design stages of the projects.

Delivery: The sophisticated nature of IGB projects require a careful selection of project delivery system (PDS) and forming project team that has the capacity to deliver. The PDS such as alliance contracting, design and construct, and build-operate-transfer seem to offer good potential for the successful delivery of the IGB projects.

People & Skills

Skills and experience: Typically organizations look at project management skills for selecting the members of the project teams. So project management provides a benchmark and a good starting point for assessing people's capabilities to work on IGB projects. However, as the delivery of IGB projects require knowledge of complex technologies, green construction and achieving a balance between technologies and living experience, so up-skilling the current level of project team skills may be needed. The current level of people knowledge and experience seem to vary widely among top, middle and lower tier suppliers and builders in the construction and operation process. Since the various levels of suppliers, builders and contractors are intertwined in construction supply chain, so it is vital that the up-skilling of knowledge occurs across the various tiers of the construction industry for the successful delivery of IGB projects. Project management can help achieve these goals through creation and transfer of knowledge.

Educational and professional qualifications: The construction process of IGBs needs to be supported by people with right level of education and professional qualifications. Universities and other training providers need to work with industries to understand the latest developments and develop tools and techniques required for effective management of IGB projects. Currently, Green Building Council of Australia provides accreditation to professional operating in sustainability industry. However, much more need to be done to transfer best practice knowledge and industry guidelines on consistent basis for successful delivery of construction projects. Project management entities such as PMI and APM can also help develop qualification that provide required knowledge to professional wanting to operate in intelligent building domain.

Project Leadership: Given the complexity of IGB projects, project leadership is critical to success of these projects. Project management body of knowledge identifies a number of soft skills and leadership qualities that are considered necessary for achieving success in projects (Hwang and Ng (2013). Use of these skills and qualities by project managers are expected to help IGB projects to their successful delivery.

Attitude: The attitude of project team members is an important constituent to get commitment, communication, cooperation and coordination among the team members. Typically construction project like IGB projects are governed and executed by integrated project teams (IGTs) which requires a high dependence among various facets of project team. Hence people with right attitude would be required to make that happen. Setting ground rules, organizing team building activities, and monitoring team performance and proactive issues management will help in building right attitudes for project management of IGBs.

Methods & techniques

Methodologies / Philosophies: IGB projects can be effectively managed by using time-tested methodologies and project management frameworks. PMBOK and PRINCE2 provide systematic approach towards management of complex projects. Some organizations have their own methodologies which can then be complemented by use of best practice guidelines for management of IGB projects. PMBOK can be integrated into any methodology being used by the organization.

Tools / Techniques: Best practice guidelines prescribed in various project management frameworks provide a suite of techniques and tools that guide the project to its delivery. However, there seems to be need for integration of more techniques and tools that could cater to green construction and intelligent building project management requirements. In particular techniques that facilitate life-cycle based: cost estimating, risk assessment, quality management, and stakeholder management will need to be developed and incorporated in project management processes to influence IGB project outcomes.

Procedures / Practices: The current project management practices are a good guide for management of IGB projects. However, the evolving technologies, evolving green construction practices and solutions require ongoing identification, and integration of new industry best practices in project management processes.

Knowledge sharing

Tacit to explicit knowledge: Since every project is unique, therefore considerable part of construction related activities and work is based on expert judgement and prior experience of people working on the project. Hence, a lot of knowledge remains in the brains and exist in tacit form. Project management helps in successful delivery of IGB projects by capturing that knowledge in lessons learned and other project documents. Specially, as IGB construction projects could be more complex, therefore, transfer of tacit knowledge into creation of industry best practices would be crucial for IGB projects success and project management can help in such endeavours.

Shared repositories: Project management can serve to feed knowledge in shared repositories for the purpose of creating best practices and then using the knowledge for IGB project delivery. These shared repositories could be created at organisational level or at local or national level by project management bodies. Exchange of knowledge among experts to capture knowledge embedded in different regional conditions and contexts: Project management provide common language and culture that could breed cooperation and knowledge transfer among project management professionals working in different industries, time zones and geographical locations. Such a transfer of knowledge could lead to integration of best practices and procedures for management of IGB projects.

DISCUSSION AND CONCLUSION

The objective of this research paper is to highlight how project management can help in effective management of IGB projects. To this end we conducted a systematic literature to identify and review studies that have examined the role of project management in IGB projects. Drawing upon the review of the relevant literature, we developed a framework consisting of four key dimensions: processes, people, methods and knowledge. These four dimensions were then further divided into various sub-elements to discuss how these elements can facilitate in project management of IGB projects.

Overburdening the users with technologies and controlling their daily life style is not the objective of constructing IGBs, but IGBs are constructed to provide a rich living experience that is supported by technological sophistication, and green construction and operation (Luo et al., 2009). The proposed framework is expected to provide project managers a structured knowledge on the skills, expertise, attitudes, decision making processes, control mechanisms and effective delivery of these projects.

CONTRIBUTION, LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

The study has made a number of contributions. Theoretically, the study builds knowledge on project management approach needed for intelligent green building projects. The study will help in identifying gaps in availability of project management tools, techniques and processes that may be needed specifically for accomplishing intelligent green building projects. The research offers opportunities for exploring how project management can be leveraged to achieve success in intelligent green building.

For practitioners, this study has highlighted the key project management areas that needs attention for management of IGB projects.

This study is limited by the review of searched literature. The proposed project management framework is theoretical in nature subject to empirical validation and generalisation.

The study has highlighted the knowledge areas that require further research. We have shown that the role of project management in delivery of IGB projects is an under researched area. Future research could focus on exploring these areas.

Components	Dimensions	Sub-dimensions			
Processes & Control	Review and optimisation of current project management processes	 Review of current project management processes Refinement of existing and integration of new processes for IGB projects delivery 			
	Control	 Review of earned value management (EVM) and other project control techniques Creating an EVM system that provides a measure of performance based on the work accomplished against the critical path, particularly for work completed against capital intensive activities Mandatory stage-gate performance reviews Through involvement of multiple stakeholders 			
	Delivery	 Setting-up an integrated decision making system Careful selection of project delivery system (PDS) Integration of post-occupancy stage into PDS 			
People & Skills	Skills and Experience	 Evaluation of skills and experience availability at the initiation stage of the project Constant up-skilling of people 			
	Educational & Professional qualifications	 Collaboration among industries and academia to develop programs that provide required skills and knowledge; and prepare people for IGB projects Transfer of best practices through multi-tier peer communications 			
	Project leadership	 Development of soft leadership skills and people management qualities 			
	Attitudes and behaviours	 Developing desired behaviours through setting-up ground rules, organizing team building activities, monitoring team performance, and proactive issue management 			
Methods & Techniques	Methodologies / Philosophies	 Using best-practice guidelines and integrating these guidelines into organisational processes to achieve IGB project management maturity 			
	Tools / Techniques	 Integration of new tools/techniques to cater to uniqueness of IGB project delivery 			
	Procedures / Practices	 Constant integration of new knowledge and best practices 			
Knowledge sharing	Tacit to explicit knowledge	 Transfer of tacit knowledge to create new best practices and developing procedures for use of the new knowledge 			
	Shared repositories	 Creation of shared repositories and ensuring knowledge and less learned information is stored and distributed 			
	Exchange of knowledge among experts to capture knowledge embedded in different regional conditions and contexts	 Transfer of knowledge embedded in the work practices across regions, cultures and projects globally by creating interaction opportunities among industry experts, and the integrating the new knowledge by creating new best practices 			

Table 2	Framework	of IGB	project	deliverv
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