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Identification of Factors Influencing Costs in Green Projects

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Abstract**—**Cost has always been the leading concern in green building development. The perception that construction cost for green building is higher than conventional buildings has only made the discussion of green building cost more difficult. Understanding the factors that will influence the cost of green construction is expected to shed light into what makes green construction more or at par with conventional projects, or perhaps, where cost can be optimised. This paper identifies the elements of cost before shifting the attention to the influencing factors. Findings from past studies uncovered various factors related to cost which are grouped into five focal themes i.e. awareness, knowledge, financial, technical, and government support. A conceptual framework is produced in a form of a flower diagram indicating the cost influencing factors of green building development. These factors were found to be both physical and non-physical aspects of a project. The framework provides ground for the next stage of research that is to further explore how these factors influence the project cost and decision making.

Keywords**—**Green project, factors influencing cost, hard cost, soft cost.

I. Introduction

GREEN construction projects offer various benefits to the stakeholders such as cost saving in the long run, enhancing business competitiveness strategy, protecting the environment, producing better design which creates good indoor ambient and many more. Building 'green' creates healthy, comfortable and economically prosperous places for people to live, work and play. It promotes the delivery of buildings and infrastructure that contributes towards reducing the usage of resources and energy, minimising pollution, enhances economic efficiency and social cohesiveness [1].

The demand for green buildings is rapidly becoming the most significant trend in the building industry. While Europe and North America continue to lead in green building trend, countries from developing nations are also doing their part in pursuing green. As mature market, the growth of green building in Europe and North America are moderate in 2016, while countries from developing market i.e. Asia, MENA (Middle East/North Africa) region have reported a more dramatic growth in the percentage of green project [2]. Nine Asian countries had an average of 39% of green share in the building industry [3].

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Although the trend is present, the level of green building activity in most developing countries are still below the mainstream and are predominantly focused on large developments [4]. One of the most commonly cited green building barrier is the high construction costs [5]-[7]. Many construction players share the common perception that green construction incurs expensive additional costs. Changing this mind-set will not be easy as psychological barrier is difficult to overcome. There are many scholars who stated that green buildings can be built with little or no additional costs if they are planned properly. As costs are the critical aspects in green development, focus of previous studies have been on hard costs and potential cost savings in the long run. Soft costs, which are necessary to manage the whole project, remained elusive and their influence on developers' course of action and decision remained unclear.

As cost is a major roadblock in taking the leap in green construction, it is pertinent to understand the cost elements in green construction to counter any inaccurate perception or to recommend ways to reduce the cost problems. The paper will begin with discussing on the issues pertaining cost in green projects before critically review the cost influencing factors. The factors will be summarized into five (5) main categories i.e. people; technical; technology; external support; and specific requirement. These factors cover both physical and non-physical aspects of a project. By identifying the factors influencing cost for green projects, the negative perception association with green project cost can be alleviated through introducing mitigating action which is relevant to each influencing factors.

II. Literature Review

A. Cost Issues in Green Projects

Investors in building industry are attracted to green concept due to the potential of greater cost saving benefits and higher investment returns [8]. Unfortunately, these benefits can only be realized over a long period of time [9]. A study in New Zealand stated that the concern on cost escalation has prevented the incorporation of green features in construction developments [7]. This is supported by the study in China [10], Canada [11] and Malaysia [4]. Cost has been identified as the main obstacle for green building in the US, Colombia and Mexico [2]. Thus, another way to attract investors for green building is by ensuring that green project can be achieved without additional cost, better if at lower cost. However, past studies have mixed findings on this aspect.

While some researchers have supported findings that green building cost can be cost neutral or cost saving, others have refuted this testimony.

Cost for construction projects can be divided into 3 categories: land, hard and soft cost [12], [13]. Land costs cover the expenses for land acquisition which include land purchase, title transfer, site clearance and others. Land cost is influenced by factors such as location, land price, legal fees, stamp duties and land tax but not by the decision to go green. However, hard and soft costs are believed to be influenced by the decision to be green. Collier et al. [14] defined hard costs as actual construction costs to erect a building. It is a direct cost that is related to the physical aspect of the project such as architectural work, mechanical and electrical works, civil and structural works and other physical construction works [15]. It would be in the form of material, technology, plant and equipment, labour, building elements and many others. It is the cost mostly affected by the decision of the client, architect and engineers in design and engineering aspects. In contrast, soft costs are cost related to non-physical aspects of the construction project such as management, planning, documentation and marketing [16]. It is an indirect costs or "offsite" costs that are not directly related to labour or materials for construction. These costs include nonphysical expenses and involve all other fees involved in the completion of the project, such as taxes, insurance, fee, services, marketing etc. Yudelson [17] defined hard costs as those costs for construction, and soft costs as those costs for design and certification services. Technically, soft costs is any other costs other than building cost

While numerous research papers have discussed the issue of cost of green projects, majority of studies have focused on the hard costs such as cost related to green technology and materials i.e. whether cost will inflate or not when green features are added to meet green building requirement [10], [13], [18]. Building and Construction Authority (BCA) [19] for example, stated that green buildings are expected to cost about 5 – 10% more upfront due to the purchase of new and green technologies. Issa et al. [11] stated that cost premium of majority green buildings was only 1 to 2% as compared to their conventional counterparts, while Kats [20] indicated that cost premium is less than 2%. Davis Langdon [21] however, informed through their study that there is no significant difference in average costs for green buildings as compared to non-green buildings. As cost has always been the leading concern in green building projects, these inconsistent findings made the discussion of green building cost more difficult.

Another aspect of cost which has received little attention is soft cost. Commonly known as 'hidden' cost, it remains elusive in its contribution to green building cost increment. The bulk of additional cost in green building does not come from hard cost, but instead comes from soft cost [17]. Most of these costs incurred in administration processes which include various expenses to manage the project [12], Despite being a comparatively smaller portion in the total cost amount, its actual value can be expensive and plays a significant role in the decision to build green. Soft costs are generally estimated as a percentage of the total project budget during the planning stages, and can fluctuate as the project progresses. A significant portion of the additional costs of green building is on the soft costs of design, certification, modelling and consulting [22]. According to Northbridge Environmental Management Consultants [23], soft costs are associated with activities outside the range of construction cost and usually range between 1 to 5% in addition to the total construction costs.

Through literature, hard and soft cost can be divided into several main elements as illustrated in Fig. 1. Through various definitions [10], [13], [24], hard costs can be divided into 6 categories: architectural design, building services, plant and equipment, material and labour, civil and structural and building requirement. Soft costs on the other hand, include consultants' fee, tax, commissioning, certification, marketing and insurance [17], [25]. However, all soft costs elements can be consolidated to 3 main categories i.e. professional engagement, procedures and legal requirement [26].

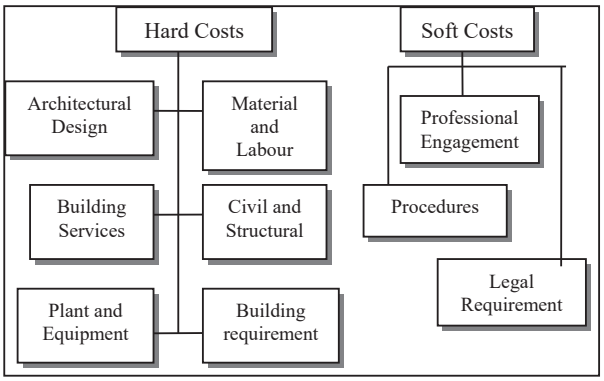

Fig. 1 Category of costs to be influenced by decision to pursue Green Projects

Each of the aspects stated in Fig. 1 is expected to be affected with the implementation of green concept in the project. For example, the design phase for green building usually demands additional exercises and services from the consultant team, pushing the consultant fee to higher rates [27]. Green buildings are expected to have green technology features installed in the building, thus, which may incur additional cost [17]. In obtaining green certification, a more complex commissioning process will be in place which embodies the bulk of hidden costs. Technically, the ultimate decision to go green will affect these costs, but the effect occurs because of certain factors, as discussed next.

B. Factors Influencing Cost in Green Project

The common perception that green buildings cost significantly more to construct than conventional buildings inhibit the move towards sustainability [28]. By understanding why the cost difference occurs, initiative can be promoted to minimise the cost increase, thus making green project more attractive. Thus, the factors that would influence the cost for

green building are being studied. The factors will be summarized into five (5) main categories i.e. people; technical; technology; external support; and specific requirement. These factors cover both physical and non-physical aspects of a project.

1. People

Those who affect the project are those that involved in the delivery of the project as well and those who determined the project context [29]. The competence, commitment and attitudes of the professionals will strongly influence the quality and costs of built facilities. The roles and services of the professionals is to primarily plan, design, deliver and maintain the infrastructure and built-environment. This is why the professionals are considered as critical players to cope with the ever-rising issues in demand for vitality to live, which take up about 3-5 percent of life cycle cost. In terms of overall project cost, Azizi et al. [26] highlighted the fee for the professional is usually 6 to 8 percent. For green construction, professionals involve is expected to have something extra. They are expected to take additional responsibility, have green knowledge and expertise, understand about environmental risk and able to advise the client and other professionals on green matter [30]. With this additional expectation, the common percentage of fee may not apply and negotiation will take place, which can vary from project to project.

Green movement should take into account the concept of interrelated wholeness or holistic solution to make sure that contributions of all interdependent parties are connected and being interacted between humans with their society, technology, economy and resources. However, the interdependency between various parties in the construction industry can be hindered by the lack of knowledge which leads to social and behavioural resistance [31]. Lack of knowledge in green building design and construction, as well as insufficient numbers of capable professional green designers has been widely cited as one of the major barriers in green building implementation [4], [32], [33]. Additionally, poor knowledge about green building design and construction lead clients to conclude that any variations in design necessary to comply with building regulations are caused from being green [34]. Lack of knowledge about green benefits makes it difficult to justify the often higher up-front costs for a green building leading to misconceptions and uncertainty about green development being communicated to the industry, and thus affects the market demand for green features [35]. Bandy et al. [36] stated that the ignorance of people on green building benefits results to a shortfall in local expertise availability in green design and construction leading to the need for foreign experts to be imported, which contribute to higher cost [33].

2. Technical

Sustainable building projects are inherently different from their conventional counterparts from the technical and technology perspective [32]. Technical refer to methodological aspect in the implementation of green buildings. Studies have reported that technical aspects such as process and procurement issues, additional rules and regulations in green building, limited availability of green materials and expertise to manage them can pose a problem in green project [37], [38]. The difficulties associated with a more complex technical requirement indicating the need for training to build-up skill, learn and re-learn process, gaining additional approval, seeking expertise outside the comfort zone etc. This non-physical action will incur cost to the parties involved. Since green products have yet to become “mainstream” in the construction industry, municipal councils and safety departments are sceptical to their use [34]. The complexity of approvals and permitting process for green buildings may also cause delays as many building codes do not cater for new environmentally friendly systems. These delays lead to greater risks and higher costs, which cause developers to hesitate to build green [35].

3. Technology

Technology refers to product use during or in the implementation. Technology could be the aide adopted during the implementation and also could be embedded as part of the end product. Technology can be divided into 2: hard and soft technologies [31]. Hard technologies relate to equipment and materials, industrial processes and physical infrastructure solutions. BCA [19] stated that green buildings will cost about 5 – 10% more upfront due to the purchase of new and green technologies. Soft technologies enhance the construction process though the use of suitable systems, models or tools that support decision making, monitoring and evaluation activities [39]. A significant portion of the additional costs of green building is on the soft costs of design, certification, modelling and consulting [22]. It is, thus vital to focus on how to make technology (hard and soft) easily accessible and available at the cost level affordable by the stakeholders. Installing green technologies will require new form of competencies and knowledge, thus more cost [10].

4. External Support

External support can be in the form of government, professional institution and financial institution support. The government has a major influence over the development of any industry. By introducing policies and regulations for controlling environment degradation, government will stimulate green movement as any regulation set by the government must be abide by the construction industry [40]. Changes imposed by the government will bring about behavioural shift in the construction sector because the government is a regulator, major customer and industry sponsor [41]. Financial instruments by the government such as incentives, subsidies and rebates are usually a voluntary scheme, but it can be motivational as it involves monetary supports [42]. With more monetary support available in the industry, developers can take advantage to reduce their construction costs.

The support from construction-related professional body usually in the form of new knowledge dissemination, introduction of new green technology or system, incentive in research and development and many more. They may not have a direct impact to the project in hand, but the knowledge advancement and training provided will increase local knowledge and acceptance towards green concept and would ideally, encourage the production of materials, technology, system etc. tailor-made for local need. Competition will increase and product or expertise available locally is usually cheaper that foreign products. The most commonly cited barrier in green development implementation is the financial constraint of green construction [43]. Finance institution is usually involved with the industry in terms of providing good financial scheme for buyers and construction firms. The support from finance institution such as bank will assist in financing the project [40]. However, more loans from the bank will lead to more interest i.e. affect the budget and cost.

5. Specific Requirement

Green projects differ than their conventional counterpart especially in terms of technology adopted and green design aspects. Green construction projects are expected to have additional construction professionals involved as there is a need to focus on green aspect of the projects such as green building facilitator and green building certifier [26]. Green Building Consultant is an additional member to the regular consultant team and shall contribute additional cost [44]. Green buildings need to undergo rigorous assessment using a green building rating tool in order to be certified green and a certain certification fee applies. This fee is charged differently depending on the type of project, scale of project, and rating tool [45]. Green buildings also have to submit to a more complex commissioning process as compared to conventional buildings which embodies the bulk of soft cost. This is to assure the green technology features installed function according to the expected performance [46]. In relation to design costs, green buildings usually require extra time and effort to the design and specification phase of a project due to incremental requirements on architects and engineers as well as the additional green consultant. Means [47] estimates that the design cost for a green building would cost 5 percent more than the typical design cost for a conventional building which usually ranges from 8 to 12 percent of construction costs. These specific requirements for green projects are another factor that will influence the overall cost of a project.

III. The Framework

This paper presents the factors influencing cost for green construction projects. These factors were obtained from extensive literature review which has been discussed in section 3.0. These factors are arranged into five focal themes namely, people, technical, technology, external support and specific requirement. Each of these factors can have impact on project cost either directly (hard cost) or indirectly (soft cost). Fig. 2 illustrates the proposed framework distinguishing each cost-influencing factor, while Table I elaborates each factor. The classification indicates that cost for green construction is affected by many aspects. All four factors (people, technical, technology and external support) are also applicable for conventional project, excluding the green aspect.

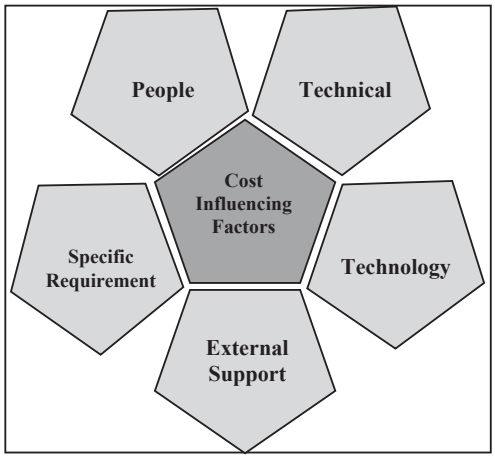

Fig. 2 Conceptual framework of cost influencing factors

TABLE I
Summary of Cost Influencing Factors of Green Projects

PEOPLE	
Competency of the people	[29], [48]
Attitude and commitment of the parties involved	[4]
Fluctuation of fee	[26], [30]
Green knowledge	[35], [36], [40]
Availability of local expertise	[32], [33], [36]
Client uncertain demand	[34]
TECHNICAL	
Process and procurement complexity	[37], [43]
Additional rules and regulations	[38]
Training requirement	[37], [40]
Complexity of approval and permit process	[35]
TECHNOLOGY	
Purchase or hire of new technology	[19], [10], [31]
Application of new system, models or tools	[22], [39]
Installation of green technology	[10]
Availability of local product	[33], [43], [48]
EXTERNAL SUPPORT	
New or revised policy and regulation	[40], [41]
Availability of incentives, subsidies and rebates	[33], [42]
Collaboration of professional institutions	[40]
Opportunity for loan choices from financial institution	[40]
SPECIFIC REQUIREMENT	
Addition of green consultants	[26], [44], [48]
Green certification fee	[45]
Compliance with green assessment requirement	[36], [40]
Complexity of commissioning process	[17], [46]
Green implementation process during design phase	[47]

However, as conventional construction is a common practice, such factors may not have much weight to cost difference. Nonetheless, one factor (specific requirement) is unique to green construction projects only. This one unique

factor is believed to have close relation with other factors. For example, one of specific requirement to obtain green building certification is to build energy efficient product. This is related to technology factor when new technology is adopted to cater for this energy-efficient requirement. Fig. 2 provides better insight of all factors that would affect the cost.

IV. Further Research

This study identifies a range of factors influencing both hard and soft cost for green projects before proposing a framework to represent the findings. While efforts have been made to extract a complete database of influencing factor under focal themes, the framework only reports readily available information from literature and lacks interpretation of the actual practice and the extent of how each factors influence the project cost. The framework provides solid ground for the next stage of research. Thus, to strengthen the understanding of the actual practice, fieldwork will be conducted qualitatively to deepen the understanding of the impact of these identified factors on the project cost. The qualitative research aims to investigate the effects of causal factors on green building, and how this influences specific decisions of developers. Consequently, emphasis will be placed on developing a range of indicators that influence developers' decisions in green building implementation. The final output of this research will provide grounds for relevant authorities and green building boards to truly realize the actual situation of green building development from the perspective of industry practitioners.

V. Conclusion

Numerous studies have cited the importance of green building as the key factor to drive the green movement forward. However, cost has been identified as the main hurdle to this movement. Yet, the topic of cost remains elusive and developers are skeptical that cost can be reduced in green development. By understanding what influence cost, action can be forwarded to address this problem and ultimately change people negative mindset on this matter. The research presents a thorough review of factors influencing cost for green projects from various sources of journals and published material. Findings of the review identify common factors cited in multiple studies and restructure them into five focal themes i.e. people, technical, technology, external support and specific requirement. These factors were found to be both physical and non-physical aspects of a project. This suggest that to ensure green projects are at par with conventional project cost-wise, cost reduction action should not be focused on hard aspect only but there are many more hidden cost that must be addressed. To ensure that the framework meets the needs of the construction industry, the findings should be confirmed through interviews and/or survey with relevant industry practitioners.

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