

## Major Challenges in Implementing Green Construction

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**Abstract:** Green construction is associated with a plethora of challenges. On the account of these challenges, this research strived to explore the major challenges associated with the implementation of green construction. A total of 346 survey questionnaires were gathered from the top to middle managerial positions in Malaysia's construction industry. The theoretical framework was established and the data were analyzed using Exploratory Factor Analysis (EFA) and Structural Equation Modeling (SEM-AMOS). The rotated dimensions were renamed as "Operational Concerns," "Government support," "Economic and financial constraints," "Lack of education and regulatory compliance," "Industrial barriers" and "Organizational challenges" based on the theoretical framework. The results from the SEM-AMOS analysis denoted that all the major challenges were full moderation. Consequently, these results were complemented with 25 semi-structured interviews among construction stakeholders. The findings from the semi-structured interviews were analyzed using NVivo-9 Software. The insights revealed that the challenges were referenced 85 times. "High overall and up-front cost" was referenced 19 times as the highest reference, while "Difficulties in transportation and logistics" was referenced one time as the lowest reference. The original contributions in this study can be seen through the mixed method approach (i.e., qualitative and quantitative) in order to identify the most prominent challenges in the construction industry. The findings concluded that identifying the major challenges would help construction stakeholders minimize these challenges and encourage them to be more attentive and open towards the challenges in green construction.

**Key words:** Challenges, green construction, survey, semi-structured interview, SEM-AMOS

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### INTRODUCTION

Construction is one of the major contributors to the environmental problems (Qi *et al.*, 2010; Xian and Qiang, 2008; Tam *et al.*, 2004; Ball, 2002) and it consumes over 30% of the total energy resources (Zhou, 2010). Most of the resources consumed in construction are non-renewable, nevertheless, they are still being used excessively which may result in resource depletion and severe environmental pollution (Xian and Qiang, 2008; Tam *et al.*, 2004). Excessive environmental pollution also creates a significant negative impact on the environment and the health and safety of construction workers (Sousa *et al.*, 2015).

**Problem statement:** Construction activities include those related to noise, solid waste, water and air pollution (Tam *et al.*, 2006; Majdalani *et al.*, 2006). Other problems apart from environmental pollution are technical problems,

such as delays in construction projects, poor quality, workmanship and project failures (Gao and Low, 2014; Son and Kim, 2015).

Therefore, the transformational change from conventional construction to green construction is very crucial to minimize these negative impacts. However, the implementation of green construction is associated with a plethora of challenges such as higher initial investment (Hwang and Ng, 2013). The higher initial investment is correlated with obtaining resources used for the establishment of complex and challenging prerequisite systems such as the green rating tools prior to the construction practices of green construction (Pan, 2010).

**Literature review:** The theoretical framework for this research was developed and adapted from various theories of green and sustainability that include challenges as the moderating effect for green construction innovation which is the driving force of

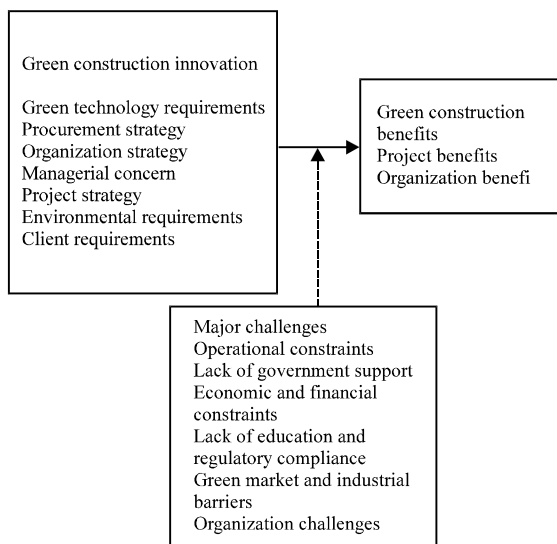


Fig. 1: The Theoretical framework (Ahmad and Endut, 2015)

green construction benefits. Figure 1 shows seven items that were described under green construction innovation, namely, “Green technology requirements”, “Procurement strategy”, “Organizational strategy”, “Managerial concerns”, “Project strategy”, “Environmental requirements” and “Client requirements”. These variables were the main driving forces to achieve the green construction benefits, namely, project and organization benefits. The challenges were accounted as the interfering variables or moderating variables. Extra cautions were needed to be taken into consideration before implementing green construction. A moderating variable as shown in Fig. 1 is the variable that “moderates the effects” of an independent variable on its dependent variable.

Social science researchers define the term ‘moderator’ as the variable that “Interferes” in the relationship between an independent variable and its corresponding dependent variable. When a moderator enters the model, the causal effects of the independent variable on its independent variable would change due to some “Interaction effect” of either increase or decrease. In other words, the effect of the independent variable on its dependent variable would depend on the level of the moderator variables (Zaimudin, 2012).

## MATERIALS AND METHODS

A total of 346 survey questionnaires were gathered from the top to middle managerial positions in Malaysia’s construction industry. The selected organizations were

obtained from G4-G7 contractors, consultants, clients and developers, who were involved directly or indirectly with green construction due to their diverse preferences, acceptance and views on green construction.

The theoretical framework was established and the data were analyzed using Exploratory Factor Analysis (EFA) and Structural Equation Modeling (SEM-AMOS). Exploratory Factor Analysis (EFA) with varimax rotation was performed which resulted in six rotated variables for the major challenges, namely, “Operational Concern,” “Government support,” “Economic and financial constraints,” “Lack of education and regulatory compliance,” “Industrial barriers” and “Organizational challenges” with all factor loadings above Sig. = 0.60. According to Zainuddin (2015), items with factor loadings of 0.60 and above will only be considered for further analysis.

Subsequently, the test of the hypothesis ( $H_1$ ) was done using SEM-AMOS for the moderating effect. It was found that all variables moderated the causal effect of “Green construction innovation” and “Green construction benefits”. The results as shown in Table 1 concluded that the type of moderation was full moderation, since, the standardized estimate for the moderators in “Low challenges” was significant ( $p = 0.001$ ) while the standardized estimate for “High challenges” was not significant ( $p > 0.005$ ). If both estimates were significant, then partial moderation would occur (Zainuddin, 2015). Once the moderation effect was established, the research was interested to determine in which group the direct effect was more pronounced. The results indicated that the moderators in “Low challenges” were more pronounced as compared to the moderators in “High challenges” since, the standardized beta estimate for “Low challenges” was greater than “High challenges” Table 1. From the above analysis, it can be observed that there was a need to complement these results with semi-structured interviews since all the challenges were comprised of full moderation and the most prominent challenges could not be seen clearly. Hence, semi-structured interviews were carried out involving 25 respondents who were comprised of the top to middle managerial positions. In addition, the respondents were composed of clients, contractors and consultants from the industrial organizations, who possessed more than ten years of experience and profound knowledge pertaining to the area of green construction. The results revealed that the major challenges that were likely to be faced in green construction were referenced 85 times by using the NVivo-9 Software. In the discussions, some keywords were used in relation to the theoretical framework to indicate why these major challenges were likely to happen in Malaysia’s construction industry.

Table 1: The effect of green construction innovation on green construction benefits for “high and low challenges”

Moderators	Standardized beta estimate		p-values		Results
	High	Low	High	Low	
Operational concerns	0.07	0.31	0.439	0.001	Full moderation
Government support	0.11	0.33	0.214	0.001	Full moderation
Economic and financial constraints	0.09	0.33	0.281	0.001	Full moderation
Lack of education and regulatory compliance	0.09	0.30	0.256	0.001	Full moderation
Industrial barriers	0.06	0.34	0.472	0.001	Full moderation
Organizational challenges	0.16	0.27	0.051	0.001	Full moderation

## RESULTS AND DISCUSSION

Table 2 presents the results from the semi-structured interviews in which the challenges were arranged in a descending order. These keywords were derived from the factors used in the theoretical framework and EFA. “High overall and up-front cost” revealed 19 references with 22.35% of total challenges which was found as the most critical challenge. On the contrary, “Difficulties in Transportation and Logistics” obtained only one reference with 1.18% which was the least critical challenge in implementing green construction. The results from the semi-structured interviews complemented the overall results of EFA and SEM-AMOS, since, the most prominent challenge was still unclear. Therefore, the main contribution of this study is highlighting major challenges faced by main construction stakeholders in Malaysia using both statistical analysis and insights from the main construction stakeholders.

**Economic and financial constraints:** “High overall and Up-front cost” with 22.23% was accounted as the highest percentage of a major challenge based on the results from the content analysis. This was in line with the research commissioned by the Centre for Housing Centralization of China in which the high up-front cost was the most challenging factor faced apart from public awareness, institutional factors and technological factors. Moreover, the research conducted in the United Kingdom indicated that clients had very limited understanding of the need to consider the lifetime running cost and the overall construction cost (Gibbs and Neill, 2015; Shi *et al.*, 2014). In commenting on the challenges in the high up-front cost, all the respondents gave the same insights with their diverse project experiences. As highlighted by one managing director of a contractor organization, green construction is expensive in a short term but in a long term, it will give many benefits. The competition among

Table 2: Major challenges in implementing green construction

Major challenges	References	Percentage
<b>Economic and financial constraints</b>		
High overall and up-front cost	19	22.35
Budget constraints	4	4.71
High maintenance cost	2	2.35
Late payment	1	1.18
<b>Lack of government support</b>		
Strict government policies and legislations	15	17.65
Lack of awareness and understanding	11	12.94
Unwillingness to implement green construction	8	9.41
Lack of skilled workers	3	3.53
Accustomed to the traditional method	2	2.35
Change in mentality	2	2.35
<b>Lack of education and regulatory compliance</b>		
Lack of knowledge and experiences	6	7.06
Lack of seminars and training	4	4.71
Lack of discipline and attitude	1	1.18
<b>Organizational challenges</b>		
Competition among contractors and manufacturers	4	4.71
<b>Operational concerns</b>		
Not enough volume of works	2	2.35
Difficulties in transportation and logistics	1	1.18

manufacturers and contractors can be seen as an initiative to minimize overall construction cost. However, most of green construction projects now a days are monopolized by the “Grade 7” contractors and thus, this makes the cost higher and competitive.

According to the Head of Assistant Director in Public Works Department (PWD), the government is unwilling to spend more at the early stage of construction. He added that the normal up-front cost for green elements is 30% higher than the conventional construction. However, if the government were willing to fork out extra money on green construction and declare the practice of green construction under the contract, the construction industry would benefit from this long-term cost saving.

Another Head of Assistant Director in PWD asserted that the government and contractors in Malaysia are gearing towards green construction, for example, the new environmental circular, the design criteria and other green requirements. Although, they become more aggressive in their approach, higher implementation cost is always the obstacle. Furthermore, three respondents also commented that the high cost challenge of green technology arises when the requirements are changed from the conventional to green construction. The scarcity of green material seems to be one of the significant factors that leads to high construction cost. Some of the materials need to be imported because the industry and green market are still new.

Subsequently, one of the managing directors argued that green technology poses a burden and is unfair to

contractors in terms of method of payment. Hence, the industry should come out with the procedures of payment in line with the production at the factory. Therefore, initiatives towards the economic and financial allocations and returns are crucial for green construction to capture sufficient financial and environmental benefits (Deng and Wu, 2014).

**Lack of government support:** Apart from the crucial significance of high overall and up-front cost, strict government policies and legislations was also considered as an important challenge which revealed 17.65%. To implement the government policies effectively, proper planning and understanding on the design of green construction are deemed as vital.

Most consultants and the government should plan their construction projects properly. Developers are much more creative and smarter in that and they can construct ahead of time and produce quality results. The government should focus on planning and delivery of society measurements. On the other hand, "Accustomed to the traditional method" and "Change in mentality" were the lowest two challenges found in this component, with 2.35% equally. It can be observed that, it is not about the attitude and mentality of contractors who are reluctant to change but the limitations on the supply materials as well as the knowledge and skills of construction players. The intention to design and implement is there but the industry is still not ready and cannot support the changes.

A respondent from this study, who was an assistant director, asserted that he had difficulties finding green suppliers and manufacturers especially in the rural area. One of the initiatives is to enforce the certificates of green construction and green label. Thus, environmental consultants should play their role in ensuring that the certificates and green label are in place and provide sufficient numbers of suppliers and manufacturers in Malaysia. Besides, the National Agenda such as the development of policies for instance, standards, legislations, guidelines and green assessment systems need to be further enhanced (Wang *et al.*, 2014).

**Lack of education and regulatory compliance:** "Lack of discipline and attitude" (1.18%) in the area of green construction was considered as the lowest challenge in Malaysia's construction industry. Only a few companies were committed with the specifications related to the environment. Nine respondents highlighted that the knowledge and skills of green construction players are still at the lower level (i.e., at 7.05%). They are quite reluctant in pursuing green construction due to their limited knowledge. For that reason, experts from other countries are essentially needed to give training to construction players, especially laborers and new

graduates. As a result, the skills and knowledge from them can be applied and practiced in future. The knowledge and education of construction stakeholders need to be improved at the planning stage throughout all project levels. In addition, everyone should work together and try to prevent the issue of working in isolation or fragmentation at the industrial level. Therefore, it can be observed that education and regulatory compliance are still at the lower level and need to be further improved.

**Organizational challenges:** Organizational challenge was one of the difficulties faced by contractors in implementing green construction. One of the challenges was the competition among contractors which revealed 4.71%. However, in Malaysia, the construction sector is monopolized by the Chinese contractors. This is due to the limited numbers of Bumiputera contractors involved in green construction.

From another insight, one of the managing contractors highlighted that the involvement of contractors in green construction is limited to Grade 7 contractors. If the involvement in green construction were open to other contractors (i.e., Grade 1-6), the competition would reduce the cost of construction materials, improve sales and increase the market value (Dadhich *et al.*, 2015).

**Operational concerns:** The "Operational concerns" challenge was referenced as the lowest among the challenges of green construction. Some insights from the respondents showed that the volume was not enough, with only 2.35%, whereas "Difficulties in transportation and logistics" with 1.18% was derived as the lowest reference for operational concerns. According to a managing director in one of the contractor organizations, having a bigger volume is a "Must" in green construction. However, in Malaysia, the volume is still not enough for green technology to come in for example, a construction of <500 units of double-storey terrace houses is considered not practical for green construction to be implemented. The reason for a bigger volume is that the IBS projects are using expensive molds. A mold for one beam costs about RM 80, 000-RM 100, 000. Besides, the distance from the supplier to the construction site also contributes to the increase of transportation cost. Among the suggestions for effective operational concerns in green construction are improvement of green design, manufacturing, logistics, handling, recycled and re-used materials, storage, transportation, waste minimization and reverse logistics.

## CONCLUSION

The semi-structured interviews in this research were very crucial to complement the results of statistical analysis (EFA and SEM-AMOS), since,

the factor loadings of all challenges were above 0.60 and full moderation. Based on the findings from the semi-structured interviews, the most challenging variable was “Economic and financial constraints” followed by “Lack of government support”, “Lack of Education and regulatory compliance”, “Organizational challenges” and “Operational concerns”.

### RECOMMENDATIONS

Therefore, the government should actively play its role in providing enough budgets and regular supervision and monitoring in implementing green construction. As Malaysia is gearing towards a developed country in 2020, the major challenges as moderators in the theoretical framework will help construction stakeholders to be more conscientious on the challenges that may occur before or during the implementation of green construction. Hence, it is hoped that the construction stakeholders will be more prepared and try to minimize them before deciding to embark on green construction.

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