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The Drivers Towards Green Construction-An Empirical Study in Malaysia

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Abstract: The transition from conventional to green construction has improved the construction industry in terms of its construction performance. However, even at the most fundamental level, there are still many obstacles towards achieving a comprehensive green construction. Therefore, this research aimed at investigating the drivers towards green construction and examined the hypothesis, H_1 = drivers of green construction has a significant direct effect on construction industry benefits. A total of 346 questionnaires survey were gathered from clients, contractors, consultants and developers. The data were analyzed using Exploratory Factor Analysis (EFA) and structural equation modeling, SEM-AMOS. The results from EFA with varimax rotation managed to arrive with seven distinct dimensions. The dimensions were renamed as "organization strategy," "managerial concerns", "project strategy," "procurement strategy", "client requirements", "environmental requirements" and "green technology requirements". Meanwhile, the construction industry benefits were denoted as "project benefits" and "organization benefits". The value for all items was significant which was >0.006 (p>0.006). Subsequently, the result of hypothesis testing using SEM-AMOS was also supported. Finally, this research concludes that the findings will help construction stakeholders identify the most important drivers towards green construction as well as improve the way in which green construction is implemented in Malaysia.

Key words: Drivers, green construction, SEM-AMOS, survey, project strategy

INTRODUCTION

Green construction is a process undertaken during construction that requires construction stakeholders to aware, understand and implement the current practices and innovation (environmental requirement, efficient resources, health and safety requirement, green technology, energy minimization, organization management and supervision, quality improvement, material saving, water saving, waste minimization, land saving, eco-labeling, research and development as well as training) to improve the conventional construction and environment (Arshad, 1985). The terms "green construction" and "green building" are often used interchangeably in the industry. Thus, it is important to discuss the differences between green construction and green building prior to drivers and benefits of green construction.

Literature review: Green construction is a significant link to construct green building. It can be categorized as land efficiency, energy efficiency, material efficiency, water efficiency and environmental protection while assuring essential demands such as quality and safety. The general goal of practicing green construction is to responsibly satisfy the needs of human development. To date, there is no specific green construction rating system or tool established in Malaysia. However, there are elements of green construction which are embedded in the green building rating systems, namely, sustainable site planning, materials and resources and innovation. Table 1 summarizes the similarities between green building and green construction in the Malaysian context.

From the above table, it can be observed that green building rating system is the assessment of the overall process of green building from its inception until operation and maintenance which is employed to obtain the green building certification (i.e., platinum, gold, silver and certificate). In view of green construction, the area focuses on the process during construction and for the purpose of sustainable development

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Table 1: Similarities between green building and green construction (Malaysia's perspective)

Green building rating system	GBI green construction
Energy efficiency (operation and maintenance)	-
Indoor environmental quality (operation and maintenance)	-
Sustainable site planningand management	✓
Material and resources	✓
Water efficiency (operation and maintenance)	-
innovation	✓

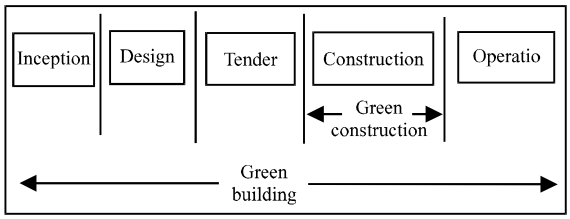

Fig. 1: The different stages of building construction for green building and green construction

(Abidin, 2010). Figure 1 shows the different stages of project life-cycle for green building assessment and green construction.

The drivers towards green construction: Generally, construction stakeholders need to play their roles and responsibilities to ensure that green construction is well implemented. They are bound to a certain level of responsibilities with which project deliverables are required to be achieved. Clients are responsible for providing the capital and operating funds for green construction. Meanwhile, government regulations can be regarded as one of drivers of green construction. Government regulations in this respect include specifying the technologies that must be used, stipulating specific environmental targets that must be achieved and introducing economic measures through the distribution of environmental costs and benefits. Regulations with fines and penalties for non-compliance have led to a more respectful attitude of contractors towards the environment (Wahid *et al*., 1995). Besides, firms which belong to more regulated industries will tend to include more environmental issues in their management strategies than those in less regulated industries. Many governments worldwide have undertaken to initiate and implement the national sustainable developments. In 2009, the government of Malaysia had introduced national green policy. Beside the legislative initiatives, the government also provided effective financial initiatives through green technology financial scheme. This scheme

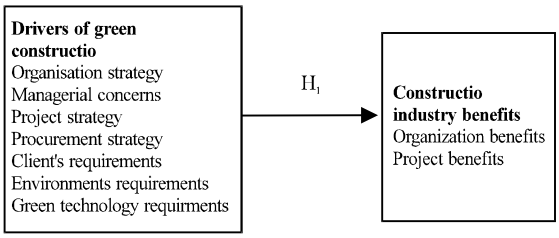

Fig. 2: The drivers of green construction on construction industry benefits

was established to encourage investment in green technology. The Malaysian government has been working on the green technology roadmap to guide Malaysia in becoming a low carbon green growth economy. For a start, the government has conducted a baseline study for green technology in Malaysia which comprises the following sectors: energy, waste water, building, transportation, manufacturing and ICT.

The effort in enhancing construction player's commitment in sustainability is not being confined to the government only. Construction Industry Development Board (CIDB) Malaysia has also played significant roles to promote the importance of sustainability in the construction industry. In 1999, CIDB initiated green technology program which has so far published several standards, guidelines and manuals for practitioner's references. They also have organized seminars to enhance the awareness of construction players on the importance of sustainable construction concept.

The aforementioned differences between green construction and green building have geared up the government to incorporate the elements of green construction such as sustainable site planning and management including material and resources efficiency in the Green Building Index (GBI) rating system in Malaysia. Since 2008, the green building rating system has become mandatory for all new buildings (Seal, 2016). Therefore, it can be part of the system that can assist construction stakeholders to implement green construction.

Hypothesis: This research was interested in determining the causal effect of "Green Construction drivers" (exogenous construct) on "Construction Industry Benefits" (endogenous construct) as shown in Fig. 2. Seven distinct dimensions were denoted for drivers of green construction while two dimensions were under construction industry benefits.

MATERIALS AND METHODS

Quantitative methodology was adopted through the distribution of questionnaire survey within Malaysia's construction industry. The data were gathered from 346 respondents from four construction organizations, namely, clients, contractors, consultants and developers. The individuals selected were among the top to middle managerial positions who were directly or indirectly involved in green construction. The theoretical framework was established (Fig. 2) and the data were analyzed using Exploratory Factor Analysis (EFA) and Structural Equation Modeling (SEM-AMOS).

Exploratory Factor Analysis (EFA): The results in (Table 2) indicated that the bartlett's test of sphericity was significant (χ^2 = 24762.175, p-value = 0.000). The measure of sampling adequacy by KaiserMeyer-Olkin (KMO) was 0.963 which was above 0.6. The KMO value was close to 1.0 and the significant value of Bartlett's test was close to 0.0 indicating that the data at hand were adequate to proceed with the reduction procedure (Zainuddin, 2012). Subsequently, Exploratory Factor Analysis (EFA) with varimax rotation was performed and seven distinct dimensions were rotated as shown in Table 3.

The dimensions were renamed as "organization strategy", "managerial concerns", "project strategy", "procurement strategy", "client requirements", "environmental requirements" and "green technology requirements".

Organization strategy: The results based on the rotated component matrix as shown in Table 3 indicated that loadings for all six items were almost equal, with "Promotion of Corporate Green Image" (Sig. = 0.735) and "Low cost of Compliance" (Sig. = 0.732) as the highest loadings while "Scope of Delivery, Limitation and Rollout Plan" (Sig. = 0.631) and "Fulfill the Function, Process, Structure and Features" (Sig. = 0.668) as the lowest loadings.

At present, key stakeholders in the construction industry demonstrate their ability to improve corporate processes and operations, become socially responsible and environmentally sustainable as well as economically viable. This implies that if organizations want to obtain their stakeholder's trust and build a good reputation in the market, they would need to provide concrete evidence that they are committed to the continual long-term improvement, thus this requires them to identify, monitor and report all social, environmental and economic effects of their operations (Asare and Yamoah, 1989).

Table 2: Kaiser-meyer-olkin measure of sampling adequacy (green construction innovations)

Variables	Values
Kaiser-meyer-olkin measure of sampling adequacy	0.963
Bartlett's test of sphericity	
Approx. χ^2	24762.175
df	2080
Sig.	0.000

Table 3: The Component and factor loading for green construction innovations

Green construction innovations	Factor loading
Component 1: Organization strategy	
Promotion of corporate green image	0.735
Low cost of compliance	0.732
Compliance with accreditation system	0.687
Effective risk management	0.672
Fulfill the function, process, structure and features	0.668
Scope of delivery, limitation and rollout plan	0.631
Component 2: Managerial concerns	
Corporate sustainability	0.765
Proper organizational structures	0.726
Working environment in an organization	0.712
Manager's concern on the environment and its protection	0.707
Role and responsibility of stakeholders	0.695
Corporate environmental strategies	0.680
Good team communication and coordination	0.657
Commitment of the top-level management	0.645
Component 3: Project strategy	
External audit environmental performance	0.704
Project environmental assessment	0.684
Environment and social regulations	0.683
Environmental policies and procedures in green construction	0.680
Measurement and reporting of compliance	0.678
Technologies processes and development	0.642
Component 4: Procurement strategy	
Industry market structure	0.743
Changing market conditions	0.734
Strategic supply chain management	0.724
Return on investments	0.659
Use of green procurement and purchasing	0.620
Component 5: Client requirements	
Clear client specifications, design and production of construction facilities	0.658
Clients strongly shape the products and processes from the very beginning of the construction projects	0.638
Financial investments in green technology	0.628
Component 6: Environmental requirements	
Ecological and Impact Management (EIM)	0.632
Environmental Impact Assessment (EIA)	0.623
Component 7: Green technology requirements	
Fines and penalties for non-compliance	0.661
Specifying the green technology that must be used	0.642

Managerial concerns: Table 3 presents the results of eight items underlying the dimension of managerial concerns. All seven items had loadings which were almost equal with the highest loading items: "Corporate Sustainability" (Sig. = 0.765) and "Proper organizational structure" (Sig. = 0.726) as well as the lowest loading items: "Good team communication and coordination" (Sig. = 0.657) and "Commitment of the top level management" (Sig. = 0.645).

It is well recognized that the commitment of top-level management within contractor organizations is a key factor that affects the adoption of green construction practices towards minimizing environmental impacts. A proper project management structure with a good working environment will be an effective means of ensuring appropriate communication and coordination of the project team. A good team communication will help minimize the ambiguity related to green construction.

RESULTS AND DISCUSSION

Project strategy: The results of the rotated component matrix indicated that factor loadings for all underlying factors were almost equal with the highest loading: "External audit environmental performance" (Sig. = 0.704) and "project environmental assessment" (Sig. = 0.684) as well as the lowest loading: "Measurement and Reporting Compliance" (Sig. = 0.678) and "Technologies process and development" (Sig. = 0.642).

Well-regulated industries had established their own green building guidelines and certification systems in the last two decades based on the establishment of technical standards (Mokkouk *et al*., 1988). Regardless of the country where a green building certification system is used, assessments of green practices during design (site selection, selection of materials, energy-efficient design, etc.) and construction (project management, resource use, construction methods, etc.) need to be performed according to the adequate standards (Adanidis and Sherman, 1995).

Procurement strategy: The results indicated that two items were marked with the highest loading, namely, "Industry Market Structure" (Sig. = 0.743) and "Changing Market Condition" (Sig. = 0.734). Meanwhile, the lowest two loadings were for "Return on Investment" (Sig. = 0.659) and "Use of Green Procurement and Purchasing" (Sig. = 0.620). Environmental or green purchasing/procurement can be referred as an integration of environmental considerations into purchasing policies, programs and actions (Lister and Bracker, 1969). Green procurement has been implemented in many countries throughout the world and can be formulated as mandatory environmental requirements.

Client requirements: The results of the rotated component matrix showed that only three items rotated under this component. These three underlying factors were almost of equal loadings, namely, "Clear Client Specifications, Design, and Production of Construction Facilities" (Sig. = 0.658), "Clients Strongly Shape the Products and Process from the Very Beginning of the Construction Projects" (Sig. = 0.638) and "Financial Investments in Green Technology" (Sig. = 0.628) (Anonymous, 1998).

Table 4: Results of hypothesis testing

Hypothesis testing	t-value	SE	p-value	Supported
H_1: Green construction has a significant direct effect on construction industry benefits	0.402	0.073	0.001	Supported

Corporate processes and operations become socially responsible and environmentally sustainable, as well as economically viable. This implies that if organizations want to obtain their stakeholder's trust and build a good reputation in the market, they would need to provide concrete evidence that they are committed to the continual long-term improvement, thus this requires them to identify, monitor and report all social, environmental and economic effects of their operations (Asare and Yamoah, 1989).

Green technology requirements: "Fines and penalties for non-compliance" (Sig. = 0.661) and "Specifying the Green Technology that must be used" (Sig. = 0.642) were summarized under green technology requirements. The results from the rotated component matrix indicated that both had almost the same loading. Non-compliance of regulations and requirements might result in fines and penalties. The amount of fines and penalties imposed for non-compliance will depend on the degree of seriousness of each violation of the environmental protection regulation (Evan and Wahab, 1983). Therefore, regulatory compliance is considered as the most important element when dealing with green technology requirements and evaluating the environmental performance.

Structural Equation Modeling (SEM-AMOS): This research was also interested in examining the causal effect of "Green Construction Drivers" (exogenous construct) on "Construction Industry Benefits" (endogenous construct) (Fig. 1). Table 4 shows the results of this hypothesis testing. The Standard Error (SE) that basically means the regression weight estimate of 0.402 had a standard error of 0.073. The result of p-value was significantly different from zero at 0.001 (two-tailed); hence it could be deduced that the following research hypothesis was supported.

CONCLUSION

It can be concluded that organization strategy, managerial concern, project strategy, procurement

strategy, client's requirements, environmental requirements and green technology requirements were the most important green construction drivers with almost equal factor loadings. The results from SEM-AMOS also conclude that the hypothesis was supported. Hence, it is hoped that the industry, particularly clients, contractors, consultants and developers, would improve the way green construction is being implemented in line with eleventh Malaysia plan "to ensure Malaysia's precious environment and natural endowment are conserved and protected for present and future generations".

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