The high amount of greenhouse gases emissions in construction industry has alerted the experts in construction industry to look into the opportunity of green building. Green building claimed to have positive impact on the environment by reducing the carbon emissions, enhance workers productivity and provide long-term economic benefits. However, the adoption rate of green building in Malaysian construction industry is not that high compared to other developed countries. This paper aims to identify the key challenges that faced by the construction industry supply chain professions, such as engineers, developers, architects and contractors. Questionnaire survey was used to collect data in this paper. Thirty-six valid responses were received and used for analysis. The results shown that the most important barrier was the lack of market demand on green building. This seems to imply that the supply chain agents are rely on the demand of clients to decide on their level of involvement in green building. The results of this paper could contribute in raising the awareness among the supply chain agents in taking proactive steps in investing in green building by stressing its benefits to their clients.

1. Introduction

As of 2019, the building works in construction industry were accountable for 30% of greenhouse gases (GHG) emissions [3]. This significantly high amount of GHG emissions together with inefficient energy consumption from buildings could contribute to climate change, such as global warming and affects the sustainability of natural habitats [5]. To address these issues, green building is regarded as one of the potential solutions, by most of the developed countries, such as Australia, China, Italy, and the United Kingdom (UK) [8, 9].

Green building could be defined as a building that help to minimize negative impacts to the environment, while enhancing the occupants’ comfort and financial aspect [3]. Various research had proven the benefits of implementing green building. Such benefits include the reduction of GHG emissions [11], and enhancement of occupants’ health and productivity [3, 8]. However, some people may regard green building as high construction cost and hence reluctant to invest in green building. Studies had been conducted by various researchers on the viability of green building and identified it to be profitable to the occupants throughout the lifecycle of the building [12]. The results of cost premium analysis for the green building had proved on its feasibility [13].
Rating tools to access green building features, such as BREEAM, green star and LEED, had been developed to assess the building performance, which generally based on the efficiency of energy and water; sustainable management and planning; innovation; and quality of indoor environment [14-16]. With the reference to the developed rating tools, Malaysia had developed its own rating tools, namely Green Building Index (GBI), that specifically suitable for its tropical weather and community needs, to nurture the green building development in Malaysia [17].

Despite the benefits and rating tools existed for the green building in construction industry, the adoption of green building in Malaysia could consider at the beginning stage if compared to other developed countries [18]. There are only a few examples of building that embrace green building concept, such as Securities Commission Mesiniaga Tower, Perdana Putra, University College of Technology Sarawak and Diamond Building [19-21]. These buildings are mostly commercial building, but little residential property be classified as fully adopting the green building practices [22].

To provide a better overview and strategy for the adoption of green building, this research aims to examine the barriers to green building application in Malaysian construction industry. This research focuses on the opinions of supply chain agents to provide an overview of such professions on the adoption of green building technologies and features in Malaysia.

2. Identification of potential barriers

Different studies had been conducted to examine the challenges of green building implementation. For examples, [10] utilised questionnaire survey to collect the opinion of project managers in developers firms in Kuala Lumpur and Selangor, [2] examined the opinions of developers in Indonesia with regards to the challenges in adopting green building, [6] looked into this area from the building experts’ perspectives in the United States, and [1] conducted a study in Ghana, specifically discussed on the barriers related to green building technology adoption. However, most of the studies were conducted outside Malaysia (such as Indonesia) and did not combine the perspectives of a wider group of professions (such as engineers, designers, quantity surveyors). The barriers extracted from literature review were tabulated in Table 1.

| Barriers                                           | 1 | 2 | 3 | 4 | 5 | 6 |
|----------------------------------------------------|---|---|---|---|---|---|
| Lack of green building regulations and codes       | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Lack of subsidies on green technology              |   |   |   |   | ✓ |   |
| Lack of training related to green building technologies | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Lack of awareness of existing incentives           | ✓ | ✓ | ✓ | ✓ |   |   |
| Lack of awareness on the benefits of green building technologies | ✓ |   |   |   |   |   |
| Lack of environmental awareness among developer and consultant |   | ✓ |   |   |   |   |
| Lack of information and databases on the green technologies | ✓ | ✓ | ✓ | ✓ |   |   |
| Low market demand by clients                       | ✓ | ✓ | ✓ | ✓ | ✓ |   |
| Lack of research in local context on green building technologies | ✓ | ✓ | ✓ |   |   |   |
| Limited time for green practices implementation    | ✓ |   |   |   |   |   |
| Resistance to change by the supply chain agents    | ✓ | ✓ |   |   |   |   |
| High cost                                          | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Limited finance support for the up-front cost       |   |   |   |   | ✓ | ✓ |
| Clients’ preference on the instant payback benefits |   |   |   |   | ✓ | ✓ |
| Risk and uncertainties for new green technologies   | ✓ | ✓ | ✓ | ✓ |   |   |

Note: 1 = [1]; 2 = [2]; 3 = [4]; 4 = [6]; 5 = [7]; 6 = [10]
3. Questionnaire development
The barriers that identified from the literature review were further classified into four categories, which are barriers related to government and policy, barriers related to knowledge and awareness, barriers related to local professionals, and barriers related to economic and finance (see Table 2). Codes had been assigned to each barrier for the ease of data presentation and discussion.

| Code | Barriers                                      |
|------|----------------------------------------------|
| G    | Barriers related to government and policy     |
| G1   | Lack of green building regulations and codes |
| G2   | Lack of subsidies on green technology        |
| G3   | Lack of training related to green building technologies |
| K    | Barriers related to knowledge and awareness  |
| K1   | Lack of awareness of existing incentives     |
| K2   | Lack of awareness on the benefits of green building technologies |
| K3   | Lack of environmental awareness among developer and consultant |
| K4   | Lack of information and databases on the green technologies |
| K5   | Low market demand by clients                 |
| P    | Barriers related to local professionals       |
| P1   | Lack of research in local context on green building technologies |
| P2   | Limited time for green practices implementation |
| P3   | Resistance to change by the supply chain agents |
| E    | Barriers related to economic and finance      |
| E1   | High cost                                    |
| E2   | Limited finance support for the up-front cost |
| E3   | Clients’ preference on the instant payback benefits |
| E4   | Risk and uncertainties for new green technologies |

The targeted respondents were developers, builder, architect, engineer, contractor, designer, consultant and project manager who works in the Malaysian construction industry (both East and West Malaysia). The targeted respondents were randomly selected from the membership list in Board of Engineers, Construction Industry Development Board (CIDB) and the web search. Two hundred questionnaire surveys were distributed through online and/or face-to-face methods. The data analysis method for this paper was descriptive statistics.

4. Results and discussion
This section discussed on the respondents’ details including their demographic details, and the barriers that affecting the implementation of green building.
4.1. Respondents’ details
Thirty-six valid responses were received, which is 18% of the response rate. Out of these 36 responses, 50% of the respondents were engineers (18), 25% of them were consultant (9), followed by contractors (14%, 5), architect (5%, 2), builder (3%, 1) and developer (3%, 1). Therefore, the majority of the respondents have engineering backgrounds. Sixty-seven percent of the respondents had more than five years working experience, while 28% of the respondents had more than 21 years of working experience. This seems to imply that the respondents who have varies level of experience, could provide a better overview of their opinions from different stages of working experiences.

In terms of the participants’ involvements in green building, 64% of the respondents had experienced green building technologies in their project, but out of these number of respondents, 83% of them identified their involvement in green project was not more than five projects related to green building. Sixty-five percent of the respondents involved project related to green building in West Malaysia, 30% of them have involved in green building project in East Malaysia, and 4% of the respondents involved green project in both East and West Malaysia.

4.2. Barriers of green building implementation
The respondents were asked to rank the level of importance of each barrier, with 1 being not important and 5 being extremely important. Table 3 showed the descriptive statistics of the barriers.

| Code | Mean | Standard Deviation | Rank |
|------|------|--------------------|------|
| G1   | 3.53 | 0.97               | 7    |
| G2   | 3.44 | 1.34               | 12   |
| G3   | 3.44 | 1.00               | 11   |
| K1   | 3.89 | 1.06               | 2    |
| K2   | 3.81 | 0.89               | 3    |
| K3   | 3.56 | 0.87               | 6    |
| K4   | 3.61 | 0.87               | 5    |
| K5   | 4.25 | 0.81               | 1    |
| P1   | 3.39 | 1.05               | 13   |
| P2   | 3.25 | 1.00               | 14   |
| P3   | 3.53 | 1.18               | 8    |
| E1   | 3.75 | 1.16               | 4    |
| E2   | 3.44 | 0.98               | 10   |
| E3   | 2.53 | 1.00               | 15   |
| E4   | 3.47 | 1.27               | 9    |

The results showed that “K5 - Low market demand on green building” was ranked as the most important barrier. This seems to imply that the respondents who are the supply chain agent relied on the client demand to provide green building. As supported by [23], this scenario could be classified as vicious circle of blame, as the supply chain agent and demand-side stakeholders are blaming each other for not providing/investing in green building. There is possibility that the clients are unaware...
about the benefits of green building and hence leads to the low demand, and low implementation of green building.

Lack of awareness on the existing incentives (K1) was ranked as the second most important barriers. This was supported by the literature in [1, 2, 4]. It seems to imply that the respondents may not be fully aware on the supports and/or incentives that provided by the local government for investing in buildings that have green features. It is interesting to note from Table 3 that the three most important barriers that selected by the respondents were all classified under the category of knowledge and awareness barrier. The other barriers that classified under policy and economics seems to be least important if compared to the awareness barriers.

The fourth most important barrier was “E1 – High cost”. The respondents could opt that building which consists of green features is having high capital cost or high maintenance cost. This may create an impression to the developers that selling properties with green features could be burden, as most of the buyers are looking for affordable property price.

The fifth most important barrier was the limitation of information and databases (K4). Different professions and/or stakeholders are involving in the construction industry, and hence created information at different project stages [24]. There is no proper system which could collate the information into a single database in Malaysia, and hence leads to the loss of information at different project stages [25].

The following barrier was “K3 – Lack of awareness on green technologies benefits”. This seems to contradict with a studies conducted in US, as the US green building experts were reported that lack of awareness as the second most important barriers [8]. However, the differences in geographical location and cultures of different countries, may lead to the discrepancies on the barriers’ rankings.

In terms of the lack of regulations and codes in relation to the green building (G1), the respondents may perceive that the current codes and rating tools in Malaysia, such as Green Building Index (GBI), is not being fully understand by all the stakeholders. This barrier is consistent with the findings in [8, 9].

Two barriers under the category of economic and finance, which are Risk and uncertainties for new green technologies (E4), and Limited finance support for the up-front cost (E2) were ranked as the ninth and tenth most important barriers. These seems to imply that the stakeholders are looking for the financial support or more affordable price of the green technology.

The five least important barriers classified by the respondents were “G3 - Lack of training related to green building technologies”, “G2 - Lack of subsidies on green technology”, “P1 - Lack of research in local context on green building technologies”, “P2 - Limited time for green practices implementation” and “E3 - Clients’ preference on the instant payback benefits”. All of these barriers were from the categories that related to government policy, local professionals and economics. This may imply that the respondents reckoned they have sufficient awareness on the green building, but there are hindrances from the external sources.

5. Conclusion
This paper provided an overview on the factors that affect the implementation of green building in Malaysian construction industry from the perspective of different professionals, which mostly consist of engineers. The main barriers identified from the questionnaire was lack of client demand on building that have green features. This seems to imply that the demand side stakeholder does not have the interest to invest in green building. The tropical weather in Malaysia may lead to the situation that the residents are not aware on the importance of green building if compared to countries that have four seasons. High cost was ranked as the fourth most important barriers. It is undeniable that green building could help with mitigating the climate change but its adoption in Malaysian construction industry still require a considerable good amount of time. As the respondents in this paper was mostly engineers’ opinions, it would be good to conduct a future studies related to clients or developers’ opinions in relation to green building. Future research could look into the barriers related to the
knowledge and awareness, as there are limited studies carried out in this area, specifically related to the storage of green building information and providing a standardised database.

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