Sustainable Construction and Its Challenges

Adhilla Ainun Musir, Siti Rashidah Mohd Nasir, Siti Hafizan Hassan, Nur Farah Asyikin Abdul Rahim, and Nurul Farah Afiqah Harun

Abstract Construction projects in Malaysia are currently facing various problems on sustainability due to the negative perception of construction activity widely spread among stakeholders. In addition, there is a gap of knowledge and awareness on sustainable construction and its practices. This led to the concerns of government and private sectors to be more proactive in minimising this problem without restraining the need for development. This study reviewed the challenges of sustainable construction from many parts of the world through various previous studies. The thematic review process was adopted as methodology of this study. The findings of this study identified the main challenges of sustainable construction which consisted of four main themes namely cost and finance; cultural and knowledge; professional and capacity; and design and technologies. These main themes are essential to the stakeholders in the implementation of sustainable construction.

Keywords Sustainable construction · Cost · Finance · Cultural · Knowledge · Professional · Capacity · Design and technologies

1 Introduction

During this twenty-first century, urbanization was closely connected to the construction sector because of its related projects such as housing and infrastructure [1]. Other than that, refer to [2] stated that environmental planning and the construction industry have merged in the sense of urbanization, which is heavily influenced by climate change policies. Besides, based on [3] also pointed out that the shift of the construction industry from the conventional model to sustainable development in the form of 'sustainable construction' had received close global attention. Sustainable

A. Ainun Musir (✉) · S. H. Hassan · N. F. A. Abdul Rahim · N. F. A. Harun
Civil Engineering Studies, Universiti Teknologi MARA, Cawangan Pulau Pinang, Permatang Pauh Campus, 13500 Pulau Pinang, Malaysia

S. R. Mohd Nasir
School of Civil Engineering, College of Engineering, Universiti Teknologi MARA (UiTM), 40450 Shah Alam, Selangor, Malaysia

S. Belayutham et al. (eds.), *Proceedings of the 5th International Conference on Sustainable Civil Engineering Structures and Construction Materials*, Lecture Notes in Civil Engineering 215, https://doi.org/10.1007/978-981-16-7924-7_85

construction can be defined as "the creation and responsible management of a healthy built environment based on the prudent use of resources and ecological principles" [4]. As there were an increase in the sustainable construction movement's growth rate throughout the world. Nonetheless, a sustainable solution and green building have a long story of being developed because of the energy crisis and the campaign to protect the environment. Thus, Malaysian construction has put a rapid process and change of interest in sustainable construction.

Construction projects in Malaysia are being criticised for the low productivity and failure to meet client's satisfaction [5]. Due to these reasons, Malaysian government has introduced the Green Growth concept to promote sustainable development for public projects and Value Management (VM) to improve the projects' value for money [5]. Hence, based on a study [6], construction industry is urged to move from traditional, labour consuming, energy inefficient and waste generated method of construction to more environmentally friendly, energy efficient and less waste generation of the construction environment. Reference [6] also stated that Malaysian projects in the last decade, especially the magnificent monuments, were not cost and function effective. On certain construction projects, the budgets were overstepped, took longer construction period and quality of the end products were poor. With those issues, Malaysian government came out with an effort to manage our natural resources and conserve the environment while mitigating the effects of climate change by implementing a Green Growth strategy under the 11th Malaysia Plan in Sustainable Development Goal 2030.

Sustainability has been defined as economic development that meets the current generation's needs without compromising the opportunity and ability for future generation's need (WCE 1987). Based on a study [7], construction industry sector is the main reason of accruing the depletion of natural resources and triggering the acceleration of climate change. The issue is worsen by having each of the construction activities including demolition and disposal which create a significant environment burden that varies considerably depending on the type and location of each building [8].

With these issues, it led the authorities, organisations, professionals, and citizens to call for a sustainable construction industry that can address the health and environmental problems which arise from buildings in order to reduce the impact of the industry on the environment and people [9] and to reduce the environmental footprint of the built environment [10]. Hence, these triple bottom line approaches (environmental, social and economic) form the framework for sustainable development.

2 Methodology

2.1 Thematic Review Process

Thematic review process [11] was adopted in this study to select appropriate and relevant articles. This approach consists of three stages which are identification, screening and eligibility [11]. In addition, manual searching method was also conducted using established peer reviewed sources such as Scopus and Web of Science (WOS). The three stages of the process are further elaborated as follows:

Identification

Identification is the method to find articles in established sources. Identification is the first stage where the identification of keywords is determined. Besides that, similar word and related keywords are identified by using dictionary and thesaurus.

Screening

Screening is the process of eliminating the unrelated articles within the study. All the unrelated articles or exclusion criteria are removed in this second stage. The most related articles based on the selection of criteria of the study are selected and reviewed.

Eligibility

Eligibility is the final stage of the thematic review process. At this stage, on a more important note, the titles, abstracts and the main content for this study are examined to ensure that they fulfil the inclusion criteria and fit to be employed in the present study in order to achieve the objectives of the current research. The articles are selected based on the criteria of the content. Finally, a total of nine most relevant of empirical data are analysed. The inclusion and exclusion criteria are stated in Table 1.

Table 1 The inclusion and exclusion criteria

Criterion	Eligibility	Exclusion
Literature type	Research articles	Book series, book, chapter in book, conference proceedings
Language	English	Non-English
Subject area	Engineering, social science, environmental	Other than engineering, social science and environment

3 Review Process

3.1 Thematic Review Process

Extensive literature search was conducted using the thematic review process where all challenges were identified and tabulated in Table 1 according to the number of frequencies of the challenges. As a result, four main themes namely cost and finance; cultural and knowledge; professional and capacity; and design and technology for challenges of sustainable construction were identified. Table 2 shows the main themes and sub-themes of reviewed articles.

The literature search on the challenges of sustainable construction was conducted from seven previous studies which focused on cost and finance [4, 12–17], while nine studies contributed to culture and knowledge [4, 12, 13, 15–20]. Meanwhile, for the professional and capacities, eight of the studies contributed to this theme [4, 12–18], followed by six previous studies on design and technologies [4, 12, 13, 16, 17, 19].

3.2 Identify the Main Challenges

In this section, the discussion on the challenges of sustainable construction revolves around four main themes namely cost and finance; culture and knowledge; professional and capacity and design and technologies along with the emerging 16 sub-themes (refer Table 2).

Cost and Finance

Cost and finance is one of the challenges that contributed to the neglected implementation of sustainable construction. In particular, these challenges include economy conditions of the contractors and perception of higher cost of using sustainable concept. In this theme, a total of seven previous studies were found particularly for economic conditions [4, 12, 13, 16, 17, 19] and higher cost of sustainable concept [4, 13, 15–17, 19] with economy conditions [12] being under this theme too.

Economy Conditions (EC)

Based on reference [12], contractors usually focus on the short-term economic conditions which are the benefits of sustainable construction. They [12] are reluctant to increase their inputs of green element in their project [8] because of inadequate access to green technologies. Moreover, there is a wide gap of knowledge and awareness on sustainable practices, but the stakeholders mainly consider economic as the main issue rather taking a serious effect on economic, environmental and social sustainability [12].

Table 2 The main themes and the sub-themes

Authors	Cost and finance		Culture and knowledge							Professional and capacity				Design and technologies		
	EC	HC	RI	LB	LD	WC	C	LA	G	LP	LS	LC	PB	DT	T	MT
Shaikha Al Sanad (2015)			/	/	/	/	/	/		/	/					
Serdar Durdyev et al. (2018)		/						/								
M. Khufallah, I. S. Ibrahim and F. Moayedi (2019)	/			/				/	/	/	/			/	/	
L. S. Ng, L. W. Tan, T. W. Seow (2018)		/		/		/	/		/	/	/	/	/			
Wenxin Shen et al. (2018)		/							/		/			/	/	/
Ofori Ametepey, Clinton Aigbavboa and Kwame Ansah (2015)		/		/			/	/		/			/	/		/
Susan Dzifa Djokoto, John Dadzie and Eric Ohemeng-Ababio (2014)		/			/	/				/		/				/
Krishna P. Dhakal, Lizette R. Chevalier (2017)						/				/	/	/	/	/		/

(continued)

Table 2 (continued)

Authors	Cost and finance		Culture and knowledge							Professional and capacity				Design and technologies		
	EC	HC	RI	LB	LD	WC	C	LA	G	LP	LS	LC	PB	DT	T	MT
B. Williams et al. (2019)		/		/	/	/		/		/	/	/		/	/	

EC Economy condition, *HC* Higher cost, *R* Risk, *LB* Lack of benefit, *LD* Lack of demand, *WC* Willingness to change, *C* Capability, *LA* Lack of awareness, *G* Guided, *NP* No policy/rules, *LS* Lack of support, *LC* Lack of capacity, *PB* Political barrier, *DT* Design/technical, *T* Technologies, *MT* Materials and tools

Higher Cost (HC)

The challengers toward sustainability seems to be related to the perception of higher cost of sustainable building-options and construction. Based on [16], the cost of building option is the highest and significant among others. The industry and the key players affirmed that the element of bias perception in sustainable construction practices instead of clear evidence of sustainable building or construction was significantly higher at initial cost which was proven by previous studies worldwide [16, 21, 22]. Study by reference [16] stated that the barrier of sustainable concept like green building arises from financial pressure. This is mainly due to the lack of government support, higher cost in preparing documentation, and the lack of training and education in the industry as key players.

Culture and Knowledge

Cultural and knowledge is the resistance and difficulty to adapt the changes on sustainable construction. It is due to the lack of knowledge which leads to lack of demand in the construction sector [4].

Risk of Implementation (RI)

The lack of understanding on the concept of sustainability leads to a small number of contractors and key players having the interest to be involved in sustainable construction. Besides that, it has caused inadequate access for international experts to explore sustainable construction [16]. Furthermore, most of the contractors are willing to adopt on the easier approach but not willing to take risk [15]. Based on study [13], the contractors are afraid to invest higher initial cost and they fear long return period.

Lack of Benefit (LB)

Most of the implementors such as designers and contractors are unaware on the benefit of sustainable construction. This is due to the lack of motivation from the government to provide rewards for those who had applied sustainable concept in the construction [12]. Thus, there is a need of policy and regulation on incentives given by the government with regard to green issues [12].

Lack of Demand (LD)

Lack of advertisement and market information related to sustainable construction project leads to the lack of demand from the key players to be involved in this type of project [12]. The poor demand for green buildings or sustainable concept is also due to lack of credible research on the benefits of green construction [18].

Willing to Change (WC)

This describes the willingness of the key players in adapting and adopting the new way of construction method and changes of technology. As much as the government has put the efforts towards the sustainable construction, it is unfortunate that most of the contractors still prefer the traditional method of construction instead of slowly

moving to apply sustainable concept. It is clear that there is a lack of effort from the practitioner and negative attitudes towards sustainable [15].

Capability (C)

The capability is the ability of the contractors or any other key players to implement sustainability. Based on a study [18], there is inadequate access to the employee's training and learning experience of implementing sustainable concepts. Besides that, the lack of most professionals and designers in taking part in sustainability is considered as the most significant barrier to the adoption of sustainability [16]. In addition, the professionals are also unfamiliar with the implementation and practices [16].

Lack of Awareness (LA)

Furthermore, it has been reported that there is a lack of understanding and awareness among professionals of the key players towards sustainable construction [12]. In addition, a study [16] found that the awareness and knowledge of sustainable construction are relatively low. Based on the study [12], the awareness among respondents only ranged from 5 to 23%. The data represented the level of implementation of sustainable construction in his country. Reference [18] identified that the lack of knowledge and awareness is the one of the factors which hinders sustainable construction in the country.

Guided (G)

There is not much accessible information on the construction industry which relates information database of product's emission; for example, to the sustainable construction of key players [12]. The involvement of professionals is needed not only in terms of knowledge but also as a team member to promote sustainable construction. Together, they can act as training providers to address the current situation and future environment in order to promote sustainable development [12].

Professional and Capacity

Professional and capacity is the most critical barrier of sustainable construction. This is due to the lack of capacity in construction sector to implement sustainable practices which will lead to the failure of sustainability [4].
Lack of Policy/Rules (LP)

Reference [18] stated that the government should introduce standard or rules related to enforcement of sustainability concept. By the enforcement, it will raise and encourage the key players to be involved in this construction industry. It was found that the citizens give little attention or ignore the rules if it is not mandatory to force them to do it [16]. It is more practical if the government enforces the standards for the sustainable concept in construction industry [18]. By implementing the rules, it will develop the belief and trust from the stakeholders which are based on the serious commitment of the government [16]. Government plays an important role in persuading stakeholders towards sustainable practices. If the government does not

play their part, it will demotivate the stakeholders to be involved in this sector. Therefore, it is important for the authorities to realize the importance of sustainability and green concept.

Lack of Support (LS)

This refers to the inadequate access of green technologies and lack of support from top management [15]. The government should offer incentives or bonus to the stakeholders who implement and contribute towards sustainability [18]. The effort from the government and the management will lead to the desires of contractors to be involved in this kind of construction. The construction industry including individual organization plays a major role in achieving successful implementation of sustainable construction [12].

Lack of Capacity (LC)

Effective implementation of sustainable construction is related to the coordination and cooperation between local, national, private and government sectors. This is because the strong support from the key players produces an awareness among them which encourages them to be involved in sustainable construction [15]. Lack of cooperation resulted into lack of knowledge transfer from policy maker to the implementors. Based on a study [14], lack of government incentive has made the key players being dare to take the challenge in the adaptation of sustainable construction.

Political Barrier (PB)

The effects of political barriers also influence the success of sustainable construction [13]. This is also related to the policy maker in which the government places legislation that requires corporate policies to be parallel with the development of various policy documents to enforce sustainability [16]. This includes changing the building codes and improving the sustainability codes. The success of sustainable construction relies on the commitment from the government with the formation of legislation [13].

Professional and Capacity

Professional and capacity is referred to as the capability of the technical part in implementing sustainable construction. It includes the designer to design, the contractors to construct, and the government to be policy maker.

Design/Technical (DT)

The lack of familiarity of sustainable concepts is the one factors of slower implementation of sustainable construction [16]. It resulted into the poor of design due to the lack of appropriate guidance to assist the designers. Therefore, it is important that technical information on sustainable construction is made in proper format and easy to access since it will lead the contractors to fulfill the sustainable design and be responsible with their works [16].

Technologies (T)

Reference [16] illustrated that the challenges on the technologies part is the most direct failure of sustainable construction. It is because most of the components contribute to the effects. The lack of environmentally materials, lack of sustainability measuring tools, lack of example of 'demonstration project', lack of technical ability in terms of design and construction and lack of skills labour are the causes of slower application of sustainability concept. These challenges are considered as technical failure because they have direct impact on the success of sustainable construction principles [16]. In terms of design, the designers have low confident in designing sustainable application into the structures. It shows that the professionals need to have very strong fundamentals of sustainable principle in order to make sure the contractors follow and fulfill all of the requirements.

Materials/Tools (MT)

Another challenge that usually arises is the difficulty in finding the resources of materials and tools. Reference [20] stated that insufficient sustainable materials leads to discouraging involvement of the stakeholders. The proper tools to produce sustainable materials are also limited. Therefore, it resulted into lack of workmanship in the construction part that contributes to the poor quality [18]. Besides that, the slow progress of construction resulted from the difficulties to get the materials locally [18]. Sometimes the materials need to be imported from elsewhere which show the lack of appropriate guidance as one of the resources challenges [18].

4 Analysis and Result

Figure 1 shows the main challenges in implementing sustainable construction. The highest percentage is cultural and knowledge theme with 39.1%. Secondly, it is professional and capacity theme with 31.25% followed by design and technologies, and cost and finance theme with 18.75 and 10.9% respectively. It shows that culture and knowledge is the main challenge in implementing sustainable construction. It consists of 7 sub-themes that contributed to the result.

This is due to the lack of benefit, lack of willingness to change and lack of awareness that give impact to cultural and knowledge. This is supported by reference [16] which stated there is a lack of benefit given to the contractors whom implement sustainable construction such as green building. Based on study [13], the main barriers in the implementation of sustainable construction is cultural change resistance. This is because of the key players' lack of willingness or effort in trying new method, new material and new tools [13].

Another main challenge in implementing sustainable construction is the professional and capacity issue. This is due to the lack of regulation and policy which is not mandatory to all key players. Currently, adopting sustainable construction is only considered as an optional instead of mandatory to the key players [8]. Furthermore,

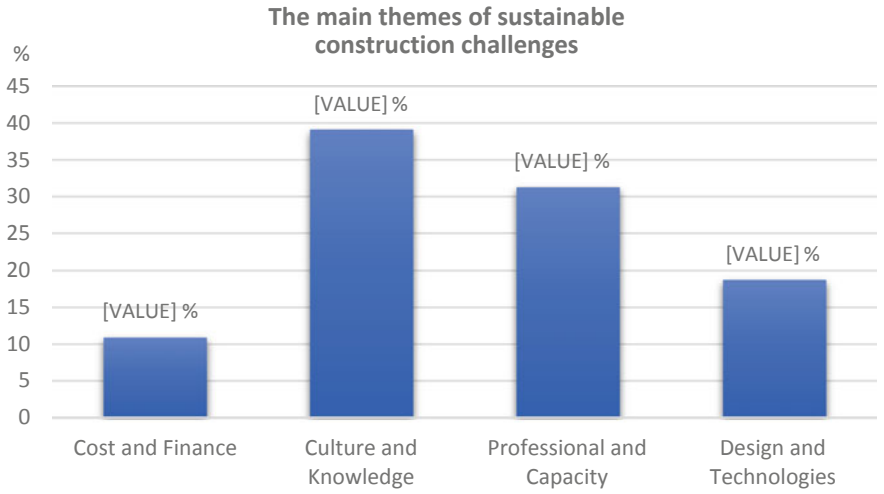

Fig. 1 The main themes of sustainable challenges

the lack of support from the government is also considered as the cause of challenges to implement sustainable construction [12].

The lack of awareness on design and technology [12] is the third challenge that causes the barrier in the implementation of sustainable construction. Besides that, a study [19] stated that there is inadequate promotion of strategies from the government to boost green building in developing countries. This also includes the lack of emphasizing technical skills in sustainable building, the use of materials and the familiarity with the sustainable rating tool or system [19]. Therefore, the demand for extension of time to prepare a design and specifications for sustainable construction projects is required. According to [23] the designers and builders are trying to find a "balance point" that bridges cost with environmental benefits. Still, these rigorous assessments and fees have made it hard to be implemented. As the design was more complicated, they required more professional with extensive knowledge in sustainable design. However, the cost to establish the expertise and hiring more professionals has become a burden to the companies.

As for cost and finance theme, a study [14] stated that the challenge is due to the current economy conditions which lead to the financial pressure of the key players. This statement is also supported by another previous finding [10] in which constructing sustainable building leads to higher project cost [16], higher cost of sustainable building option [14] and higher cost of implementation [17]. Furthermore, the higher cost for technologies, higher cost for material and too many assessment and fee are the reason to avoid sustainable construction.

This finding provides insight in developing the hypothesis of the future study. Thus, the hypothesis can be developed as below:

Hypothesis 1, H_1: The stringent policy made by the government, the more involvement in implementing sustainable construction.

Hypothesis 2, H_0: The more awareness and knowledge transfer, the more action will be taken by the key players to embrace sustainable construction.

5 Conclusion

The findings of this study highlighted four main challenges in implementing sustainable constructions. The need of implementing sustainable construction is essential to Malaysian construction industry in order to achieve the objectives of Sustainable Development Goal 2030. The lack of knowledgeable among the key players requires training programs in addressing the current and future environmental concerns within the construction industry. The attitudes among the contractors need to be changed as they are required to adapt with the new technology.

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