

The competitive advantage of sustainable construction site practices among contractors in Malaysia

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Abstract. The sustainability of construction projects is an important issue to address since the sector will grow rapidly, especially in developing countries. Excessive resource consumption and climate change due to construction activities have become critical for countries such as Malaysia which have limited natural resources water, electricity and other natural resources. It has increased pressure among construction stakeholders to adopt sustainable practices, especially during the construction phase. As builders of any construction project, contractors play an important role in promoting sustainable development to minimize negative impacts on the environment and society while maximizing their economic contribution. As a result, this research is to investigate the influence of contractors' sustainable practices during a project's construction phase and the project's competitiveness. Forty-five (45) contractors from G1 – G7 are involved in collecting their standpoints on sustainable practices through an online questionnaire survey. Statistical Package for the Social Science (SPSS) was used to analyse the collected data by conducting the Frequency Analysis and Mean Analysis. This study found that the most potential sustainable practice to be implemented is the 'reduce method' due to it is the most effective and efficient method to achieve the low production of construction wastes that meets the purpose of sustainability. While the improved image is found as the top potential competitive advantage for contractors when implementing sustainable practices to have a good corporate image to expand their businesses further. As sustainable practices are becoming more crucial, this study provides insight for contractors to foresee the benefits of adopting sustainable practices to increase their project competitiveness further.

1. Introduction

In recent decades, there has been an increase in the pressing for sustainable practices in the construction sector. This sector is one of the top three contributors to global carbon emissions and consumes a significant amount of energy that jeopardizes human living environments and health [1]. The approach towards sustainable practices in the construction industry can be implemented throughout the project life cycle. However, construction activities have a detrimental impact and affect the environment, including global warming, climate change, destruction of the forest zone, consumption of non-renewable resources, and the degradation of biological diversity [2]. Therefore, attention must be devoted during the construction phase to ensure that the project can be delivered in a sustainable way, although the construction period is relatively shorter compared with the other stages of a building's life [3].



The contractor, who is said to be the key player in the construction industry during the phase of construction has to play a role immensely in promoting sustainable construction for the long-term advantage by minimizing those negative impacts on the environment and society, while maximizing their economic contribution [4]. There are numerous benefits to contractors once they consider implementing sustainable practices. For example, evidence has shown that the initiatives to conserve and preserve environmental and social issues by implementing sustainable construction principles would help to protect the contractors' highly valuable reputations [5].

Sustainable construction is thus regarded as extremely important for the long-term viability of contractors in terms of their project competitiveness [6]. Therefore, contractors should realize the importance of implementing sustainable practices and discover immediate approaches and solutions for improving sustainability to grow their businesses further [7]. However, relatively little study has examined specifically improving contractors' project competitiveness through implementing sustainable practices in the construction industry. Thus, this paper aims to study the influence between contractors' sustainable practices and their project competitiveness to achieve a satisfying outcome.

2. Literature review

2.1 Contractor's sustainable practices in construction site

This section is to aid and provide sustainable practices in the construction site. There are several types of sustainable practices that contractors can assess during their activities on the construction site [8]. The use of energy server Florence tubes light for the lighting system has been introduced to minimize energy usage in the construction site. Besides, construction and demolition (C & D) waste are commonly produced during construction activities and should be well-handled [9,10]. By incorporating 3R's principle of reducing, reusing and recycling to manage construction waste will thus provide both economic and environmental benefits through the low total project cost originating from proper waste management [11]. Sustainable practices regarding the external environment such as noise and vibration pollution should attract a great deal of attention from contractors. One effective way is to control the noise pollution level during the operation and optimum use of construction machines, especially at the peak hour of construction activities [12]. Selection of equipment with quiet or low noise production should be the top priority to undertake any construction work. Balancing the rotating parts of the construction machineries to prevent imbalance and sharpening the blades whenever needed could also be considered helpful in sustaining a sustainable construction site [13].

Construction activities also cause several significant impacts on the indoor quality of the construction site. Thus, adopting a mobile truck wheel wash facility is a highly recommended way to clean a high volume of automobiles before leaving the site [14]. Besides, using water for clearing the site, irrigation of soils, wetting objects while sweeping, and before cutting with a saw are other possible ways to avoid dust in the construction site [15]. Furthermore, it is also recommended to utilize battery-powered equipment instead of diesel-powered to reduce the emissions of harmful gases and odours. Vehicles traveling on construction sites should also be equipped with exhaust filtration systems [16]. Next, all construction projects with building permits must be filed with a tree preservation plan that properly lists the building activity area and tree preservation area. If a tree removal permit is approved, it is an inevitable need for a tree replacement where the number and species of the replacement trees is strongly dependent on the afforded protection level of the tree removed [17].

Construction activities consume an extensive area of land, thus causing ecological sustainability to have a great deal of attention [18]. Therefore, any new project development should implement biodiversity schemes such as creating habitats for wildlife by providing nest boxes, living roofs and landscapes [19]. Other than that, managing resources in an optimal way would increase productivity and the progress of construction work. Thus, it is strongly suggested to use electronic technologies to monitor the performance of the operation of the construction activities to ensure it is according to the plan. Furthermore, it helps to properly distribute those tasks among the laborers followed by monitoring the feedback and progress of the site activities, thus controlling their performances to ensure each task is completed within the scheduled time [20]. Activities such as the emissions of gases from building

materials, excavation, and grading of the construction land, emissions of toxic cleaning products and fuel-powered generators and equipment have greatly caused the air to be polluted. These activities could be minimized by purchasing nearby construction materials to reduce the emissions of harmful gases due to the movement of vehicles [9]. Transportation also contributes significantly to the embodied carbon of buildings. Minimizing the on-site transport, including vertical and horizontal transport, is considered an approach to minimising carbon emissions during the construction phase [21]. Conservation of water is also an important factor to be included since most construction activities consume a certain amount of water. Reducing water demand and water usage could be achieved by using water recycling, incorporating water-saving devices, and good water supply management. Water collected in rain barrels can be used wisely to clean the tools or boots on the construction site [9].

2.2 Contractor's competitiveness advantages for sustainable practices in construction sites

A positive attitude towards sustainable practices by contractors during the construction phase of a project would thus benefit them to have a higher return on investment, easily recognized by the client, higher profit, easily get a project and others. Furthermore, sustainable practices such as managing construction waste by the concept of 3R which are reduced, reused and recycled would help much in the cost savings of a construction project compared to conventional construction methods [21]. Contractors would thus get a higher investment return after implementing sustainable practices. Moreover, as construction activities have resulted in severe environmental degradation due to the excessive consumption of natural resources, potential contractors with the knowledge of how to successfully manage resources in an optimal way would easily be recognized by people, thus bringing them new market opportunities [22]. Other than that, sustainable practice such as minimizing the on-site transportation by properly managing and utilizing the construction and demolition (C & D) waste to a certain extent before disposing it to the landfill is one of the keys to maximizing contractors' profits and construction revenue. It helps reduce transportation costs, which results in higher profits for contractors [23]. Besides, sustainable practices in the construction site are able to maintain the site in a safe, cleaner, and tidy condition for construction workers to proceed with their job on site [24]. It hence helps contractors to earn a good reputation from owners and could be a source of competitive advantage among contractors with innovations in sustainability in construction sites [6].

Construction activities bring numerous negative environmental impacts, which could be separated into the local and global levels. Therefore, contractors with knowledge of sustainable practices is getting more attention globally to contribute to a more sustainable built environment [25]. Sustainable practices not only benefit the contractors in terms of cost savings, it also helps in improving their corporate image [26]. Contractors who can include sustainable practices for their projects in a cost-effective way that meet owners' expectations have a higher chance of winning a project [27]. Other than that, sustainable construction with the recruitment of skilled and educated labours would greatly improve the quality of the construction projects, thus simplifying the process of delivering high quality and environmentally sustainable construction phase of any project [28]. High-quality of outcomes would satisfy the clients and slowly build up contractors' reputations with high competitiveness to gain more projects in the future [29]. A study has shown that by including the adoption of sustainable practices in construction projects, it would be easier for contractors to get planning approval compared with the conventional construction method [28]. The ease of getting approval from the local authorities could result in the early start of the construction projects, thus enhancing the productivity of the construction work, which is favored by most of the clients [30].

3. Methodology

In this research, a questionnaire survey was developed through a google form. The questionnaire survey was designed and distributed via email to construction stakeholders, solely contractors with grades G1 – G7. The targeted study area is in Johor, Selangor and Kuala Lumpur only. The population of G1 to G7 contractors in Johor, Selangor and Kuala Lumpur is 50061, retrieved from the Contractor Finder in CIDB Centralized Information Management System (CIMS) [31] with a proposed sample size of 381 [32]. As a result, a total of forty-five (45) respondents successfully responded within two months. This survey involves closed-ended questions consisting of multiple-choice questions and Likert scale questions.

The data collected from the online questionnaire survey is analysed by using the software Statistical Package for the Social Science (SPSS) to conduct the Frequency Analysis to analyze the demographic information. Moreover, SPSS software is also used to conduct Mean Score to specifically analyze the data obtained for contractors sustainability practices and the contractor's competitiveness.

4. Results and Discussion

4.1 Demographic Background

Figure 1 summarizes the respondents' registration grades. There are 11.1% of respondents from G1, 13.3% of respondents from G2, G3 and G4, 8.9% of respondents from G5 and G6. Last but not least, 31.1% of respondents from G7, which turns out to be the highest percentage, managed to be collected among the contractors. The distribution towards each grade of contractor is due to the expectation of getting different opinions. Figure 2 shows the respondents' years of experience in the construction industry, the calculated proportion shows that 55.6% of responses were collected from contractors with fewer than five (5) years of experience. Besides, 15.6% of contractors had 5 – 10 years and 20.0% with 11 – 15 years of experience, respectively. Lastly, there are contractors with more than 20 years of experience, with a percentage of 8.9%. The respondents' experience is important to ensure the collected data is trustworthy, as most of the respondents have a certain background and knowledge in the construction process.

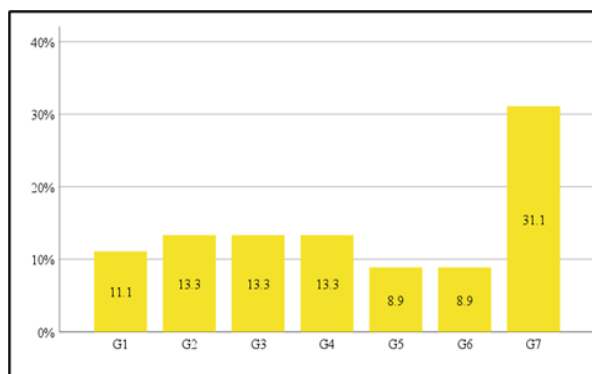


Figure 1. Contractor's registration grade

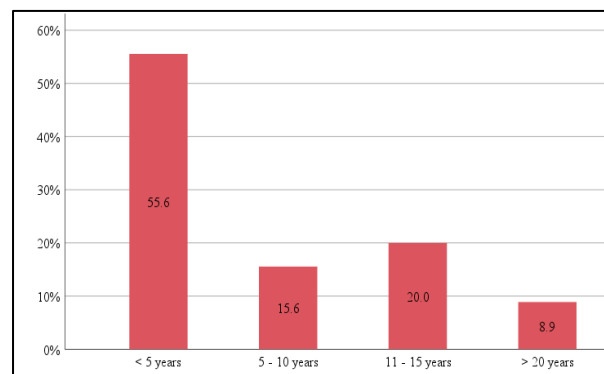


Figure 2. Respondents' years of experience

While, based on Figure 3, most of the respondents, which are 60% out of 100%, had the experience in implementing sustainable practices during the project's construction phase. This indicates the development of sustainable practices in particular areas is moving towards a positive trend. In contrast, 33.3% of respondents reflected that they are considering adopting sustainable practices in the near future. This might be due to some major challenges faced, such as the lack of financial support, which cause the contractors to doubt implementing sustainable practices. Moreover, 6.7% of respondents voted that they are not into sustainable practices. Those respondents might come from contractors who prefer to use the conventional construction method and are unwilling to change to a more sustainable type of construction.

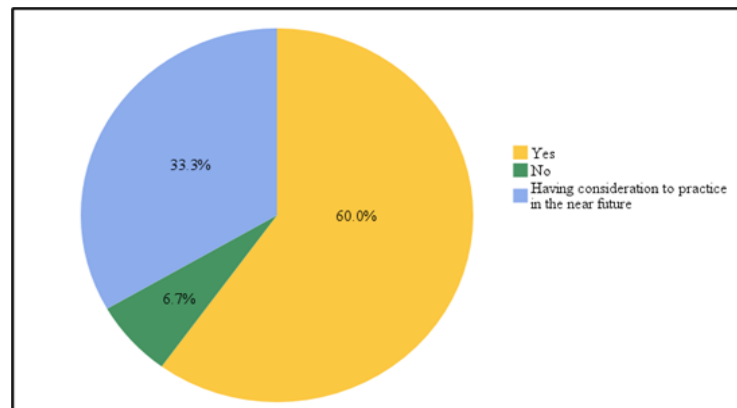


Figure 3. Percentage of respondents' involvement in sustainable practices

4.2 Potential Implementation of Sustainable Practices

The extensive literature review has somehow concluded with the identification of fourteen (14) types of sustainable practices, which are labelled from B1-B14, as shown in Table 1:

Table 1. Potential implementation of Sustainable Practices

B1 Energy Efficiency
B2 Reduce
B3 Reuse products to the fullest extent before disposing
B4 Recycle either onsite or offsite
B5 Noise pollution
B6 Managing vibration pollution
B7 Reducing dust and Mud
B8 Controlling odours
B9 Landscaping
B10 Protecting the ecological environment
B11 Resource Management
B12 Controlling air quality
B13 Transportation -minimising on-site transportation and travel distance
B14 Water and Sanitation

Mean Analysis is used to analyze the results of potential implementation of sustainable practices. From Figure 4, 'reduce' (B2) was ranked as the highest potential sustainable practice to be implemented with the mean value of 4.42, followed by reusing the construction wastes to the fullest extent before disposing off (B3) (mean = 4.22). To avoid depleting natural resources and protect our environment, reduction and reuse are the most effective strategies compared with other sustainable practices [9]. "Reducing dust and mud such as using mobile truck wheel wash facility and large façade safety nets" (B7) rated as the third potential sustainable practice to be adopted, with a mean value of 4.16. The mobile truck wheel wash facility is suggested to help in cleaning a high volume of automobiles effectively before they leave the site [14]. The affordable price of the large façade safety nets has attracted the interest among contractor to use them to protect nearby areas from falling debris and dust. "Transportation such as minimising the on-site transportation and reducing the travel distance" (B13) ranked as the fourth potential sustainable practice to be implemented, with a mean value of 4.16. The contractors should practice selecting nearby available construction materials to reduce the need for the long travel distance for material transportation. Controlling air quality (B12), with a mean value of 4.11, ranked as the fifth potential sustainable practice to be implemented. This might be due to most of the

activities on the construction site emits harmful and toxic gases to the surrounding environment, which have greatly affected workers' health. "Energy Efficiency" (B1) ranked as the sixth potential sustainable practice, with a mean value of 4.11. This is because a huge amount of electricity is consumed during the construction stage to power machinery and tools on the construction [33]. Protecting the ecological environment such as obeying the biodiversity schemes, etc. (B10), controlling odors (B8), and managing vibration pollution (B6) are the least in ranking with respect to the potential sustainable practices to be implemented, with a mean value of 3.96, 3.91 and 3.69, respectively. There is a lack of understanding among the construction industry professionals in Malaysia regarding a good biodiversity scheme that would protect natural wildlife habitats [19]. While in terms of controlling odors, especially the odors due to the emissions of gases from the transportation used, Malaysia has just adopted stricter exhaust emissions standards which leads to a low acknowledgement and knowledge among the construction practitioners to control the emissions from the exhaust of the vehicles used in the construction site [34]. Besides, managing vibration pollution by using vibration dampers is only suitable for large vibration surfaces. More expenses are needed to hire skilled workers in balancing the rotating parts of machineries [13].

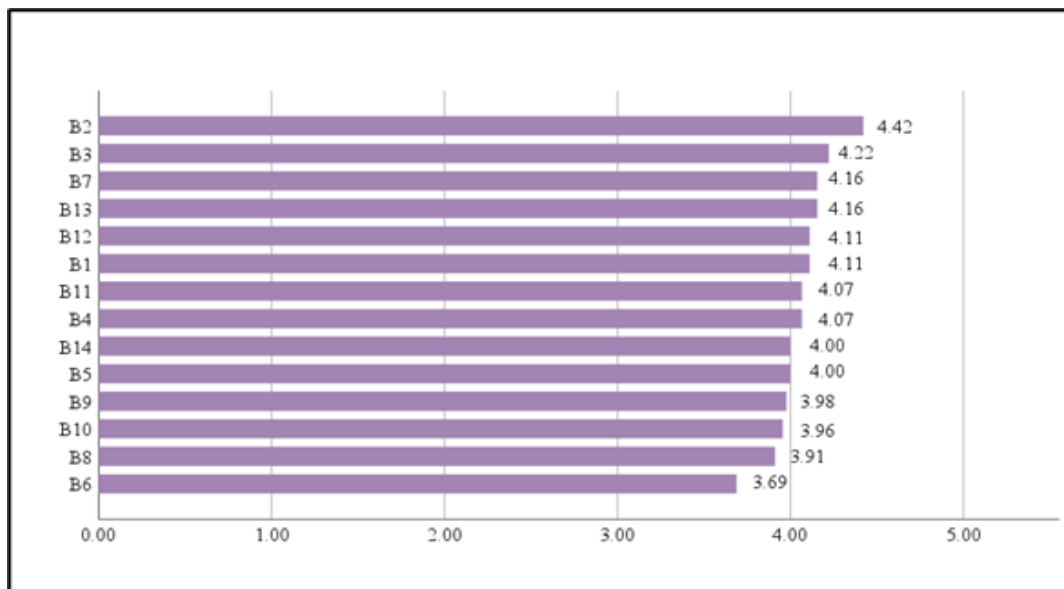


Figure 4. Potential sustainable practices to be implemented on construction site

4.3 Contractor's competitiveness advantages based on the implementation of sustainable practices

Based on extensive literature review, it is found that there is eight potential for contractors' competitiveness when implementing sustainable practices. This can be seen in Table 2, which is labeled as C1-C8.

Table 2. Contractor's Competitiveness

C1 Higher return on investment
C2 Easily recognized by people
C3 Higher profit
C4 Chances of getting a project
C5 Improved image
C6 Higher competency
C7 Higher quality of projects
C8 Higher productivity of projects

Mean Analysis was adopted in analysing the results of the potential competitiveness a contractor would gain based on implementing sustainable practices. Figure 5 shows the perspectives on each competitiveness. Among eight (8) potential competitiveness listed in the online questionnaire survey, improved image (C5) was ranked as the top agreement gained when implementing sustainable practices during construction. The mean value achieved is 4.22. Contractors' consideration in implementing sustainable practices to overcome the consequences of a construction caused to the natural environment would reflect a good image. The initiatives of contractors in protecting the natural environment through the implementation of sustainable practices reflect that the contractors do not prioritize their profits solely, thus leaving a good impression and image to increase their project competitiveness. Higher quality of projects (C7) was assessed as the second most agreed criterion, with a mean value of 4.20. High quality of any construction projects is much needed by the developers or owners. Adopting sustainable practices during the construction phase, such as the implementation of indoor quality would result in a better project performance. Therefore, a sustainable and free-polluted site is favorable for all the clients or developers to reward the contractors with more projects in the future. Higher competency (C6) achieved a mean value of 4.11 rated as the third factor that would impact the competitiveness level among the contractors. Contractors with sustainable practices during the construction work would highly improve their level of competence within the construction industry to successfully bid for a project [5].

Additionally, contractors who can include sustainable practices for their projects in a cost-effective way that meet owners' expectations have a higher chance of winning a project [27]. Higher return on investment (C1), higher productivity of projects (C8), and higher profit (C3) are the factors that would less affect the project competitiveness. C1 and C8 have the same mean score with a mean value of 3.69. While C3, has a mean value of 3.44. Although adopting sustainable practices allows the contractors to gain a higher return on investment, they still perceive that the significant benefits would be on the environment and social aspects, not in terms of the financial return [35]. Besides, they have less preference for the sustainable type of construction because initially, they might need a longer period to adapt to the construction sites' new management, which might reduce their productivity. Most respondents also did not consider the criterion of higher profit as it is deemed a long-term advantage.

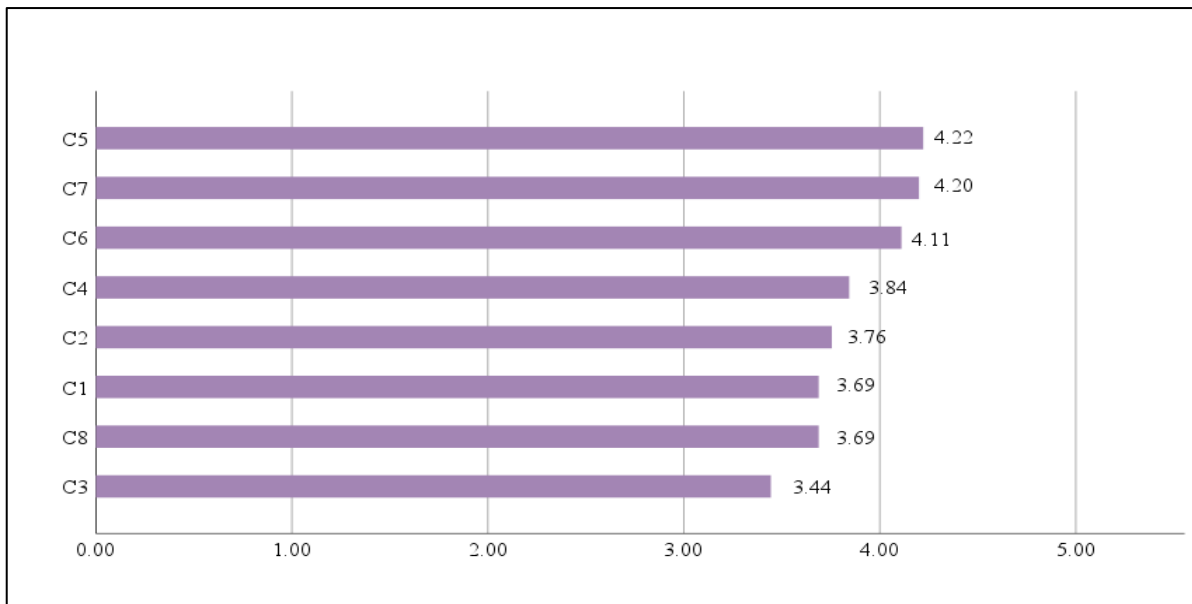


Figure 5. Competitiveness advantages based on the implementation of sustainable practices

4.4 Correlation between Contractor's sustainable practices and competitiveness

Then, a Pearson correlation coefficient was performed to evaluate the relationship between the implementation of sustainable practices and the contractor's competitiveness. The result as shown in Table 3. Contractors sustainable practice and competitive advantage have a statistically significant linear relationship ($r=0.45$, $P<0.002$). This shows that the direction of the relationship is positive and the association is approximately moderate ($0.3 < r < 0.5$).

Table 3. Correlation between contractor's sustainable practices and competitiveness

Correlations				
			Contractors sustainable practice	Competitiveness
Spearman's rho	Contractors sustainable practice	Correlation Coefficient	1.000	.415**
		Sig. (2-tailed)	.	.005
		N	45	45
	Competitiveness of contractor	Correlation Coefficient	.415**	1.000
		Sig. (2-tailed)	.005	.
		N	45	45

** . Correlation is significant at the 0.01 level (2-tailed).

5. Conclusion

Although Malaysia has started to embrace the idea of sustainable practices within the construction sector to protect our natural environment, the adoption rate among the contractors is still at its pioneer stage, mainly due to financial-constraint. Contractors do not consider sustainable practices as their long-term catalysts for better performance in the future, thus causing them to unforeseen the impact of sustainable

practices on their project competitiveness. However, the fact is that implementing sustainable practices, especially during the construction phase of a project, would add weightage to the positive side of the development of the construction projects, resulting in a better corporate image of the contractors' firm. To promote the widespread adoption of sustainable practices in current construction projects and to give the contractors insight into the potential competitiveness they would gain, this study is intended to investigate the significance between contractors' sustainable practices and project competitiveness. The feedback from the contractors were identified through an online questionnaire survey, where the potential sustainable practices to be implemented, contractor's competitiveness based on the implementation of sustainable practices and strategies based on challenged to accelerate the adoption of sustainable practices were ranked by forty-five (45) respondents according to their criticality.

The results revealed that the top six potential sustainable practices were reduce, reuse, controlling dust and mud, well-managed of transportation, well-controlled air quality and energy efficiency. First, it shows that most contractors prefer to adopt these sustainable practices, which cause a more severe impact on the natural environment if they are not properly managed. Besides, they are more masters and knowledgeable in these sustainable practices, which are more commonly practiced in Malaysia. Secondly, the results indicated that the top three potential competitiveness were improved image, higher quality of projects, and higher competency. This reflects that implementing sustainable practices would help the contractors enhance their business's competitiveness by having a good corporate image and outstanding quality projects with high competency. Lastly, the results also show the significant correlation between sustainable practice and competitiveness which indicated its importance for contractors to plan their capabilities and improve business model to gain more projects in the current competitive construction industry.

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