

Perception of Green Roof and Flat Roof Development in High Rise Buildings in Malaysia: Pros and Cons

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Abstract: The environmental impact of construction activities occurs from the initial work stages to the construction period, operational period, and the final demolition when a building comes to the end of its life. In order to make sure the construction activity can be run in line with considering the environmental health, green roofs are very relevant to Malaysia which is now experiencing rapid urbanization and loss of green areas in most of its major cities. On the other hand, flat roofs have a wide application in many countries, following the architectural evolution, the emergence of new materials, and the improvement in the performance of the existing ones. This study focuses on the perception of building industry players in the green and flat roofs development in Malaysia's high-rise building. A questionnaire was distributed to the local building sector in order to fulfill the objectives of the study which are to identify the advantages and disadvantages of green and flat roofs that concern the construction practitioners, to analyze the barriers of the green roof development, and to provide strategies to enhance the implementation of green roof in Malaysia's construction industry. At the end of the study, green roofs seemed able to offer healing environments but has a limited of roofing materials, skilled labors and professional team required, high consideration of structure, and high installation and construction initial cost.

Keywords: Green Roof, Flat Roof, Advantages, Disadvantages

1. Introduction

The environmental impact of construction activities occurs from the initial work stages to the construction period, operational period, and lastly, the final demolition when a building comes to the end of its life [1]. According to the briefing note by Willmot Dixon company, the estimation of global pollutions that can be attributed to the building is 23% of air quality, 50% of climate changes, 40% of water pollution, 50% of landfill waste, and 50% of ozone depletion. That means the construction works

of a building and its operational period are hurting the environmental health from time to time. The prominent need for environmental sustainability has led to the introduction of green technology in Malaysia [2]. One of the sustainable solutions for a long-term basis is the development of a green roof [3] and the construction of a green roof on a building can provide various ecosystem services such as reduced energy consumption and urban heat island effect, improve stormwater management, and benefits to the wildlife habitat [4]. Even the development of green roofs is still lagged, yet it is increasing. Forest City in Johore Bahru, Ilham Tower in Kuala Lumpur, and Acapella Residence in Shah Alam are examples of green roof development in Malaysia.

On the other hand, flat roofs have a wide application in many countries, following the architectural progress, the production of new materials, and the improvement in the existing performance. The success of a flat roof is related to its ability in fast construction works and providing a useful area for the building [5]. This type of roofing system has been favorable especially in the construction of high-rise buildings inside and outside of Malaysia. With the norm of the flat roof application in the building industry, it has become way challenging in persuading building owners to take a turn from a flat roof to a green roof for the construction of their building. The economic development of a green roof is actually ahead of the traditional flat roof but the convenience, safety, cost, and accessibility of a flat roof have been the main factors why they are always being chosen in the construction of a high-rise building [6]. Turning to the green roof will facing a lot of challenges to the professional players such as developers or owners, architects, engineers, consultants, and contractors. In order to understand the situation, this study is focusing on the pros and cons of both green and flat roofs system. The objectives of this study are to identify the advantages and disadvantages of both green and flat roofs system that concern the construction practitioners, to analyze the barriers against green roof development, and to provide strategies to enhance the implementation of green roofs in Malaysia's construction industry.

1.1. Environmental concern of construction environment

Environmental issues due to the construction activities are globally known around the world [7]. To realize an effective environment, identifying the construction impact on the environment is a must [8]. This section discussed on the several impacts of construction activities found by the previous studies. In year 2019, Redwick & Kasen stated that lack of vegetation cover and greenery on land is the most significant factor contributing to the heat urban island phenomenon [9]. They also mentioned that to mitigate urban heat island effects and lowering air temperature, increasing urban vegetation could be helped. Unfortunately, urban areas in developing countries are mostly have limited green due to the high density of building construction and premium land prices. Before that, Karen in 2013 stated that structures with non-vegetated and non-porous surfaces like roofs absorb the heat energy then convert it into sensible heat which causes an increment in the surrounding air and surface temperatures [10]. In the same year, Laurent in her study found that the involvement of various construction equipment and natural resources in the construction works generates many pollutants such as debris [11]. Debris from the construction site can lead to haze problems and air pollution which can affect the air quality and human health. Based on the research by Enhassi, noise pollution was ranked the second position as the environmental impact of construction projects [12]. The noises from construction works and road traffic cannot be avoided but green roofs able to absorb sound waves from the noises. Lasts but not least, in 2015, Banting mentioned that uncontrolled stormwater runoff has many cumulative impacts on humans and the environment including flooding, damage to public and private property, eroded streambanks, sediment clogs waterways, fills lakes, reservoirs, kills fish and aquatic animals, widened stream channels also loss of valuable property [13]. Green roof characteristics including the growing medium and the drainage layer influence the water retention capacity as well as the runoff dynamics.

1.2. Cost estimation

Society demands from construction industry for the cost reduction and construction time are increasing from time to time [14]. A study by Ulubeyli et al., in comparing twelve (12) types of roofs, they found that reinforced concrete flat roof was determined as the most used of roofs in Turkey's housing project [15]. Unnecessarily for detailed roof construction, installation of the solar system, and avoiding additional construction costs in the future have made it a roofing system with low construction cost and

became favorable in Turkey. In other perceptions of flat roof cost, Marrana stated that the maintenance of a flat roof is cheaper than other types of a roof due to fewer elements needed to be removed to access the waterproofing system [16]. This can be concluded that a flat roof has low construction cost from the initial construction period to the maintenance period. While for green roofs, Feng mentioned that the cost needed for green roof construction varies for every country [17]. As in Germany, lower green roof price is due to a high quantity of ongoing research and development of green roofs. But as for the newer market as Malaysia, the initial construction cost can be high because no economies of scale exist and the competition is scarce. Other than that, the requirement for skilled laborers might be needed since lack of experience and the tendency to use custom design systems. Green roofs cost more than the normal traditional roof but it has its advantages and benefits in the long run which will counter the initial cost of installation [18]. The same goes to Zalivako's statement where he found that the cost of extensive green roofs is lower than traditional flat roofs if the whole life span is being considered [6]. But, once the industry has established itself, the cost of the green roof might be a drop by 33% - 50% [19].

1.3. Construction time

The installation of extensive green roof is easier and way flexible, that caused most of researches to focused on the implementation of green roofs in harsh environment [20]. Cascone stated that an extensive green roof installation process is technically simple, can be installed on a larger slope, and appropriate for large-sized rooftops [21]. He also mentioned, the material transportation, material handling, and maintenance works are simpler and quicker. The simpleness and easiness of construction and installation works may reduce the total construction period. For the construction of flat roofs, a roof contractor website, royalroofing.com, claimed that flat roof is type of roof with quick and easy installation and re-roofing process. This is because of it type of plain structure so few materials and equipment to worked with.

1.4. Structural and wind load consideration

Since the development a green roof means addition of soil and greenery loads, high consideration in structural system is required [22]. In calculating the load of green roofs, the engineer must note that the weight of the green roof materials will vary greatly depending on how compacted and moist they are. This is supported by Shin and Kim where they said that the vegetation planted (include shrub and succulent plants) on green roof exerted relatively load on building structure [23]. While green roofs are focused on the structural load, flat roofs are focusing on the wind load. But the provision for wind loads on flat roof are differ considerably between current wind loading standards in different jurisdictions [24].

2. Materials and Methods

A collection of questionnaires was planned and circulated in the local building sector, consisting of 6 sections as showed in Table 1. Those questions are designed to allow for a rational qualitative and quantitative analysis of the results. Section A is the respondent's profile and their organization, including respondent's education, position, job experience, and current workplace based. Section B is the familiarity of respondents with the development of flat roof and green roof. Section C and D is the advantages and disadvantages of flat roof and green roof. Section E is the barriers to the implementation of green roofs. Lastly, section F is the strategies to enhance the implementation of green roofs. The data was extracted into Statically Package Social Science (SPSS) software and the analysis that been used in this study are as followed: Frequency analysis is first used to represent the description of the data of the respondent and is then tabulated. The respondent's answer is essentially divided into two (2) parts (green roof and flat roof). By understanding the category of respondent distribution, the study can easily be performed on the basis of their ratio. Next is mean analysis, the mean value score of a particular data set is equal to the sum of all the values separated by the actual quantity of values in the data set. A mean is the same as an average. So, with mean analysis the data easily to conclude final ranking of questionnaire. Next is standard deviation analysis. The standard deviation is a variable that It measures the dispersion of a dataset compared to its mean and is calculated as the square root of the variance. Moreover, by evaluation of each data point's variance mean is the average and the standard deviation is

calculated as the square root of variance. Besides, there is a greater variance within if the variables are further away from the norm, the data collection. Therefore, the more the data is spaced out and the larger the standard deviation. Percentage of total sum analysis Finally, the percentage of total sum analysis was performed and serves as the main reference for the interpretation of this study. The percentage is a number or ratio expressed as a fraction of 100. It shows the value and can compare each other. From this analysis, it easier to make a discussion and arrange the ranking based on the respondent's vote.

3. Results and Discussion

3.1. The advantages of green roof and flat roof

Based on the results in Table 2, the results showed that 49 (98%) of respondents agreed that the most advantage of green roof is offer healing environments. Next, 48 (96%) of respondents agreed it also can provide rainwater buffer, enhance the biodiversity, also have an aesthetic value and stylish. Other than that, 47 (94%) of the respondent's perception on the green roof benefits are it can reduce ambient noise from inside and outside the building also can reduce urban heat island and heat demand. 46 (92%) of respondents acknowledged that green roof can acts as stormwater management during monsoon season and rainy days. With the total value of 45 (90%) respondents, they also believed that this type of roof can purifies and improve air quality, addition in building's value, has high erosion protection, and provides energy efficiency to the buildings. 44 (88%) of the respondents agreed that increasing the solar efficiency and good insulation for heat and cold also are the benefits of green roofs. As these issues have the percentage that higher than 80%, thus this study assumed it as the advantages of the green roof development. On the other hand, 46 (92%) of respondents agreed that the most advantage of flat roof is it has a low construction cost. Next, 44 (88%) of respondents agreed it has less labor cost and workforce. Other than that, 43 (86%) of the respondent's perception on the flat roof benefits are it has easier and low maintenance works and cost, also has fewer complications in repair and damage (low maintenance). Lastly, 42 (84%) of respondents acknowledged that flat roof has benefit in the fire protection system. Since other issues have the percentage that lower than 80%, then it does not count as advantages for flat roof.

3.2. The disadvantages of green roof and flat roof

Based on the results in Table 3, the results showed that 46 (98%) of respondents agreed that the most disadvantage of green roof are limited of roofing materials, skilled labors and professional team required, need high consideration of structure, and high cost of initial construction and installation. Next, 45 (90%) of respondents agreed it also requires structural improvement. Other than that, 44 (88%) of the respondent's perception on the flat roof disadvantages are it has leaking and draining issues, unreliable in heavy rain and wet weather location, less stability and ability to withstand load naturally, and additional features needed. With the total value of 45 (90%) respondents, they believed that this type of roof lack of drainage system. For flat roof, 46 (92%) of respondents agreed that the most disadvantage of flat roof is it also has leaking and drainage issues as green roof, and need regular cleaning works for debris and dirt. Next, 43 (86%) of respondents agreed it has unstylish and less attractive roof design. Since other issues have the percentage that lower than 80%, then it does not count as disadvantages for flat roof.

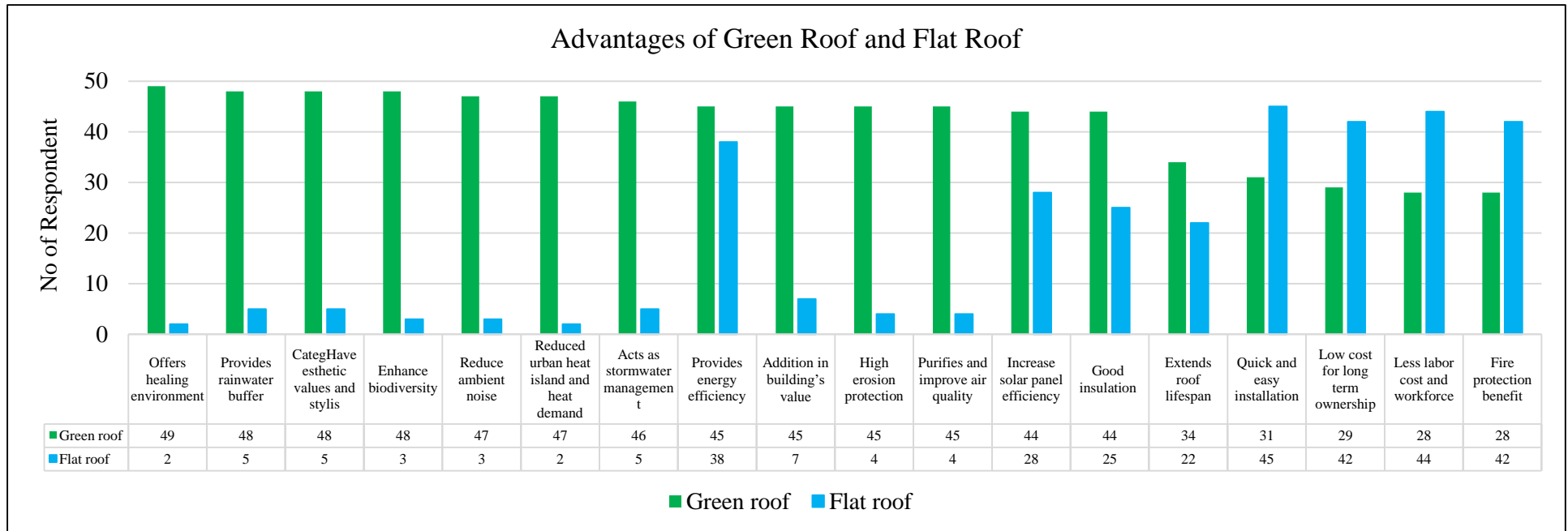


Figure 1: Advantages of flat roof and green roof

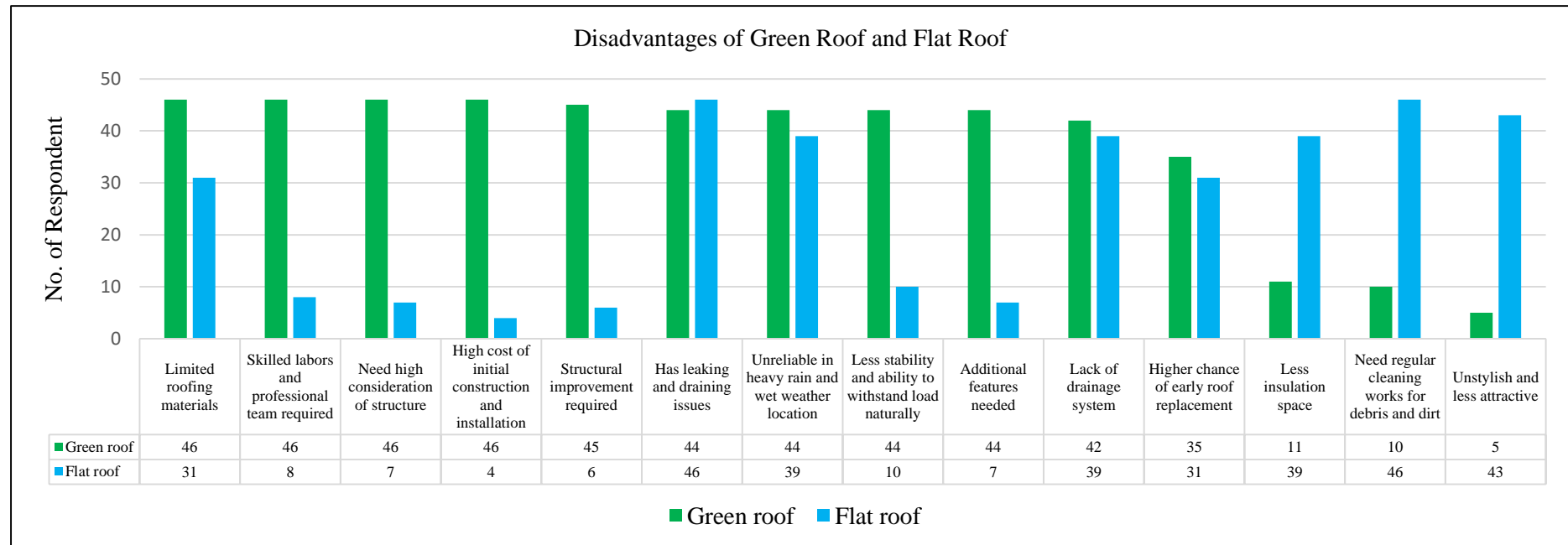


Table 2: Disadvantages of flat and green roof

3.3. The barriers in the implementation of green roof

Based on the results in Table 4, with the highest mean of 4.56, respondents are agreed that the major barrier in the implementation of a green roof is a lack of expertise in applying and getting green building materials. The second highest mean with the value of 4.52, lack of skilled manpower and tools seems to be disrupting the development of green roofs in Malaysia. For the third highest mean, with the value of 4.50, respondents believed that lack of incentives from the government is one of the major barriers in efforts to increase green roof development.

Another barrier for green roof development in Malaysia with a mean value of 4.48 is an additional design cost. Next are lack of environmental consciousness, lack of knowledge, poor information dissemination, and high construction initial cost are having mean values of 4.46 each. Then, with the mean value of 4.44, other barriers in the green roof implementation are lack of owner or client’s interest regarding green roof and increase in the building structural loading. Lastly, with the lowest mean value of 4.42, respondents are agreed that lack of environmental missions and strategies can be a barrier in the green roof development. Overall, all the mean values are high, they range from 4.42 – 4.48 and have a mode value of 5. It can be concluded all the barriers mentioned in the questionnaire can affect the construction of green roofs.

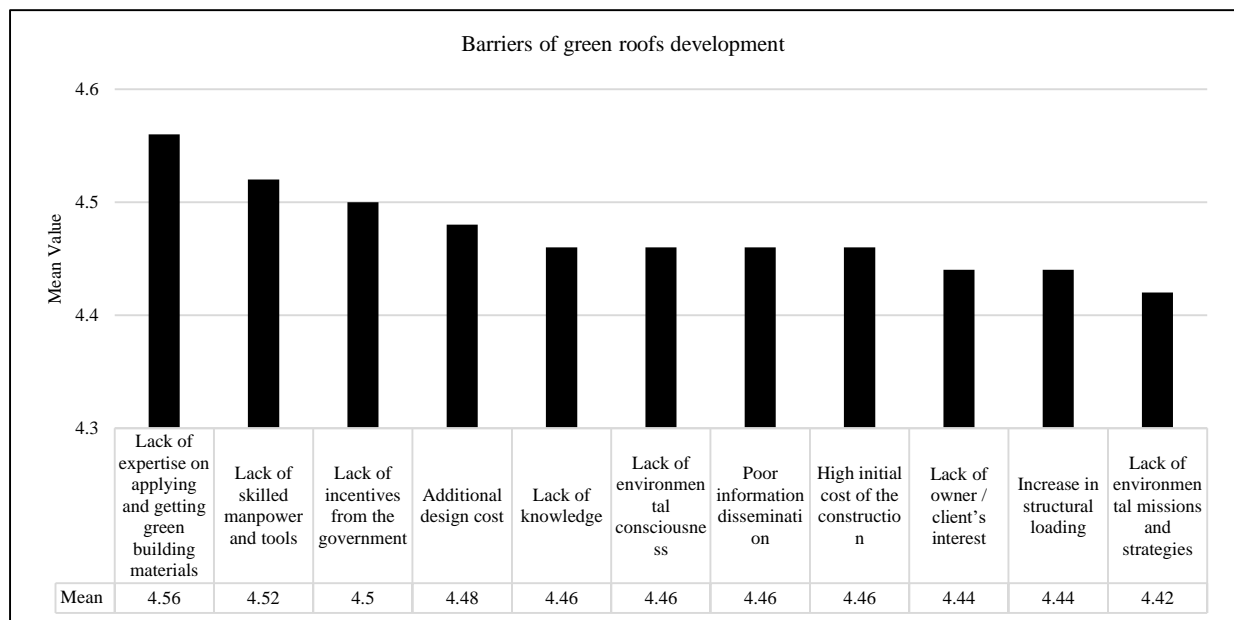


Table 3: Barriers of green roofs development

3.4. The strategies to enhance the green roof implementation

Based on the results in Table 5, with the highest mean value of 4.80, respondents are agreed that conferences about the benefit of the implementation of a green roof could help to increase the number of green roof construction and development in Malaysia. The second highest mean value, 4.78, developing awareness of the environment at the workplace can also attract construction players to be involved with the green roof. Next, 4.76 is the third-highest mean value, which applied to the strategies of green roof introduction as one of the excellent constructions in the construction industry and the university curriculum.

Next, with a mean value of 4.74, respondents agreed that other strategies to increase green roofs development are the government need to mandate the construction industry to use green roof in the high-rise building, promote green roof to the construction practitioner, and improve the legislation of green roofing system in Malaysia. Last but not least, with the lowest mean value of 4.72, mobilizing

building owners on the importance of the green roof and subsidizing the cost of green roof construction seem also can be the strategies to green roof implementation. Overall, all the mean values are high, they range from 4.72 – 4.74 and have a mode value of 5. It can be concluded all the strategies mentioned in the questionnaire can increase the construction of green roofs.

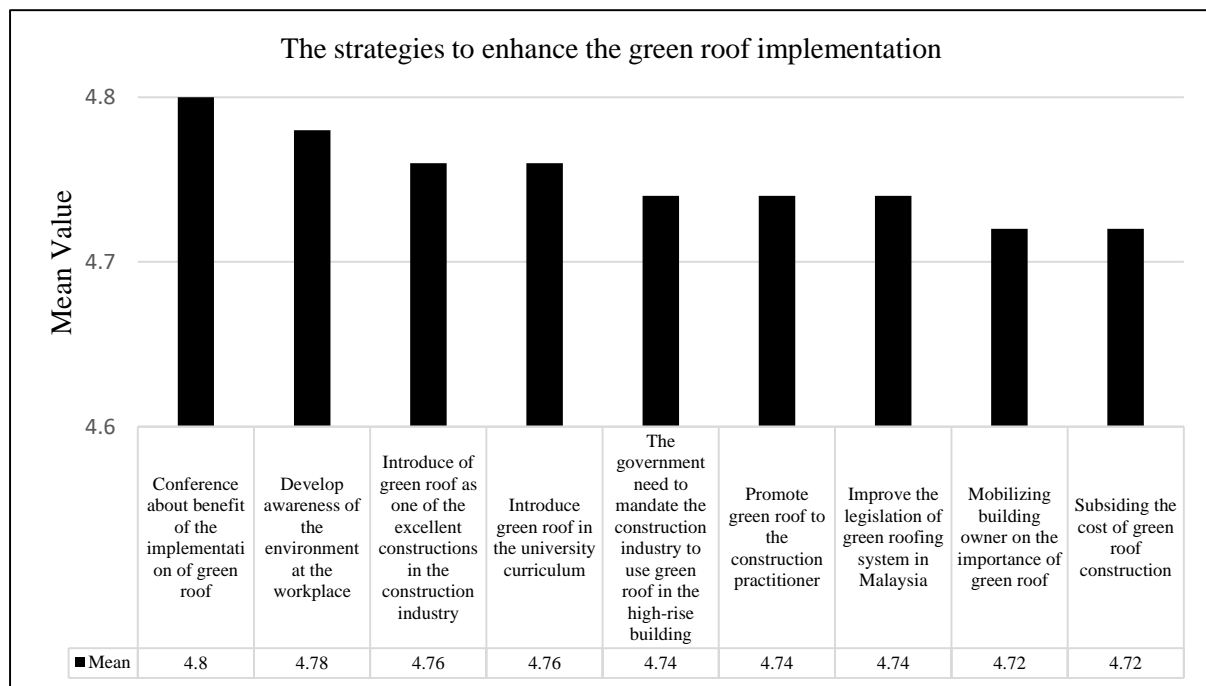


Table 4: The strategies to enhance the green roof implementation

4. Conclusion

The findings from the questionnaire revealed that, although most of the construction practitioners are used to the construction of a flat roof, they are still waiting for a chance to be involved in green roof development. 90% of the respondents are agreed that green roofs are fit for Malaysia’s construction industry. Although the development of green roofs in Malaysia is still lagged behind other countries, the potential is encouraging as nowadays more green roofs are being implemented. First and foremost, putting efforts to promote awareness, knowledge, technology, expertise, and local material are highly recommended. Activities such as conferences, workshops, and events could help and attract the public and construction practitioners to understand the beauty of green roofing systems. Without any exposure to the green roofs, communities are still unaware of its existence. In order to promote green roofs, gaps in technology, expertise, and knowledge need to be filled. In encouraging green roof implementation, more efforts need to be taken especially by the key players such as developers, architects, consultants, and contractors. Construction practitioners and construction practitioners to-be need to have an interest in this type of roofing system first, with this interest, then much research and implementation of a green roof can be taken. Green roofs are always be seen as a roofing system with various disadvantages, yet this research has proved that the advantages of green roofs have overcome the drawback and should be known by the public.

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