IMPORTANT ISSUES IN MAINTAINING VERTICAL GREEN WALL

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ABSTRACT

Vertical green wall is referred as systems that installed and applied the plantation and vegetation across the vertical wall of building in order to provide impact on improving the built environment. Vertical green wall has been proposed as an alternative for space cooling and reduce building energy consumption. From this, the maintenance of vertical green wall system is necessary to be carried out. However, there are several issues in implementing the maintenance of green wall according to the previous studies, and none of these studies have accentuated the most critical issues in vertical green wall maintenance. Therefore, this research is conducted to identify and rank the most critical issues in maintaining vertical green wall from the perspective of property managers. This study adopts case study approach which carries out on few selected types of buildings that installed with green wall system which is located at Kuching District and Kota Samarahan District in Sarawak, Malaysia. This research involved in mixed method and undertook systematic review analysis, descriptive analysis, and frequency analysis. The finding of the study has ranked the most important issues in maintaining green wall. Overall, finding proved that safety issue and high maintenance cost are the most important issues in maintaining vertical green wall. This research is significant as it could assists building designers and property managers in maintaining vertical green wall through discovering the most critical issues in vertical green wall maintenance.

Keyword: *Vertical green wall, maintenance issues, property management.*

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1. INTRODUCTION

The growth of population and urbanisation has led to the volume of green space reduced in city areas and this situation causes the problem of Urban Heat Island. Vertical Green System (VGS) has been proposed as an alternative for space cooling and it has the potential to reduce the building energy consumption. VGS is referred to the plants grow vertically attached to the building wall surface. VGS is occasionally considered as green wall, vertical garden, and green vegetation. It could be categorised into two classes which are green facades and living walls (Bustami et al., 2018; Perez et al., 2014; Ahmad Ridzwan, and Norshamira, 2016, as cited in Othman et al., 2018).

There are several advantages of green wall implementation. According to Manso & Castro-Gomes (2014), it provides a noise barrier, enhances the quality of air, and reduces the temperature which directly bring implications for improving the environmental issues of urban areas. Other than that, the green wall has the functions which act as an insulation layer to the building in winter meanwhile also act as shading that provides cooling effects towards the building in summer. Besides, installation of green wall provides more significant impacts of building environment compared to green roof application because the area surface of building wall is usually greater than area of roof of building especially for the high rise buildings (Bustami et al., 2018; Perez et al., 2014).

The earliest implementation of natural elements on the building design is from the ancient time, which is the Hanging Gardens of Babylon that was built in 600 B.C. (Jain, & Janakiram, 2016, as cited in Othman et al., 2018). Since then, the green wall concept has been established. Over the last few decades, it is developed by using various techniques and species of plants in application of green wall as there is a professor of landscape architecture, names Stanley Hart White has presented the modern green wall concept. In the year of 1980, Dr. Patrick Blanc has also developed the theory of vertical garden and the concept was becoming widespread in the sector of built environment (Othman et al., 2018).

There are some defects for the green wall application to the buildings. For instance, green facades which also known as climbing plants could damage the building surfaces because of the moisture of the plants and the plant roots attached towards the building wall. For the living wall, as its attributes are different from green facades as it needs several of support systems and planting media to be installed onto the building wall and consequently it would become heavier and more complex than green facades (Sari, 2017). Thus, the maintenance of green wall is necessary to be carried out in order to sustain the performance of green wall building.

Nevertheless, it consists of some issues of vertical green wall maintenance. According to Dr. Patrick Blanc, who is a scientist of The National Centre for Scientific Research (CNRS) and a professional for vertical greenery system had indicates that without the knowledge and ideas on implement the green wall maintenance would causes the plants withered. In fact, inferior or mediocre regime in maintaining the vertical greenery could diminish the survival of plant (Chew & Conejos, 2016). Dr. Blanc also express that vertical green must be more sustainable compared to horizontal green due to the maintenance of VGS is more difficult as it is hard to access. Moreover, green wall is considered new which compared to rooftop greenery. It consists of more issues on fall protection and safety access meanwhile it is lack of technical information related to the safety assessment. Indeed, it could have safety risk for the maintenance if the safety measure or site risk assessment is not conducted

priory (Behm & Hock, 2012). Green wall building is expensive to install and maintain because it involves with high cost of installation, irrigation system, plan species and panels as well as the high maintenance costs which is comprising of substitution of plant species, water pipes, panels, and prunig costs (Rakhshandehroo, Yusof & Arabi, 2015). The green wall development focused on many systems design and elements in order to implement better technical solutions and great performance in every phase of installation, replacement and maintenance of building (Manso & Castro-Gomes, 2014). In short, there would require many working process or activities to be conducted during green wall maintenance. Therefore, there are obviously several issues on maintenance of vertical green wall according to previous studies.

However, none of these studies have accentuated the most critical issues in vertical green wall maintenance. Therefore, the aim of this study is to assists building designers and property managers in maintaining vertical green wall through discovering the most critical issues in vertical green wall maintenance. Henceforth, this research is conducted to identify the issues in vertical green wall maintenance and rank the most important issues in maintaining vertical green wall to achieve this research aim. This research will rank the most important issues in maintaining vertical green wall from property management perspective based on selected case studies.

2. LITERATURE REVIEW

2.1 Green Wall

Green wall is a system that the plant attached vertically on the building surface and the different green wall typology are used to design by architects which integrating the green wall system with construction of residential, commercial, public building and so on (Wood et al., 2014). Green wall also known as “vertical garden” which is the vegetation that covering on the vertical wall surface (Green Roofs for Healthy Cities GRHC, 2008, as cited in Jaafar et al., 2011).

2.2 Classification of Green Wall

According to Manso and Castro-Gomes (2014), the green wall is classified into two categories which are living wall and green facades. It is assorted according to the construction system of green wall.

Living wall is defined as the plantation attached or fixed to the internal or external vertical wall surface. The living wall system is amalgamated the plantation, irrigation system, growing medium, and drainage system to the wall surface of buildings (Growing Green Guide, 2014). It also comprised of vertical modules, plant panels, or prevegetated blankets which attached vertically to the wall of building surface (Green Roofs for Healthy Cities, 2008; Birkeland, 2009; Chiang and Tan, 2009; as cited in Jaafar et al., 2011). This living wall implementation can apply variety species of plants. Living wall can be categorised into continuous living wall and modular living wall. The continuous living wall is a vertical green wall system that do not need subtract of soil and it is installed in lightweight and absorptive screens in which the plantation are interposed individually. This type of green wall system generally required hydroponic technique where the water supply is mainly guaranteed by installing irrigation system to the building

structure. The nutrients and water that absorbed by roots are through the permeable layer. The modular living wall is requiring the complementary structure of supporting elements such as planter tiles, vessels, trays and so on in order to fix and support the plants grow on the vertical wall. The growing media with organic or inorganic of soil substrate is required for the modular living wall. Meanwhile, the irrigation system is usually applied between the panels so that the plants can be irrigated through the panels by the irrigation system (Palermo & Turco, 2020). The living wall could act as attractive public art as it could be implemented with beautiful design features by green architectural designer. It also has the function of buildings insulation from the aspect of noise pollution and shading of building wall surface. With this, it would lead to enhance of air quality and cool down the microclimate in urban areas (Growing Green Guide, 2014).

Green facades is a system which implementation the hanging or climbing plants across the building wall. It could be either grow upwards or grow downwards along the vertical surface of wall (Manso & Castro-Gomes, 2014). Green façade generally rooted at the base of structures such as from the rooftop, ground, or in intermediate planters (Kontoleon & Eumorfopoulou, 2010). In other words, green facades can be identifying based on the growing media that placed either on the ground, rooftop, or intermediate heights of the building while the plantation grow vertically across the building wall surfaces (Azis, et al., 2019). Green facades can be classified into direct and indirect green facades. Direct green facades is the climbing plant attached directly to the wall surface of building while the indirect green facades is the application of climbing plant with a supporting structure towards the building. There are several types of support system such as steel mesh and wire cable, fibreglass mesh, wooden trellis panels, and so on. The selection of types of support system for implementation green facades is according to the species of green facades and its growing patterns characteristics. The green facades usually require about three to five years to have full coverage on the building wall (Manso & Castro-Gomes, 2015; Jaafar et al. 2011). The planter boxes placed at the intermediate heights are required for the situation of the very high building or lack of space at the base or rooftop of building (Palermo & Turco, 2020).

2.3 Maintenance of Green Wall

According to the Oxford Dictionary, maintenance means that an action of preserving a situation or condition of being preserved. In other words, it also defined as an action of sustaining and keeping something in good condition. Maintenance in terms of buildings is defined as a process to manage, regulate, preserve, and conserve the conditions and physical of the buildings, equipment, facilities in order to sustain the current standards and the value of it (Nawi et al., 2017).

2.4 Categories of Green Wall Maintenance

There are some defects which would lead to the green facades damage the surface building as well as the replacement of plantation is required for the green wall building. With this, the maintenance and protection of green wall system is needed based on the plants selected, conditions of surrounding, design of the green wall and so on. Based on El-Zoklah (2016) as cited in Thakor et al. (2020), there have several categories of green wall maintenance.

Firstly, the green wall maintenance can be categorised in establishment maintenance. It is

the procedures of maintenance that is necessary to be carried out within the first year or second year after the implementation of green wall system is accomplished. The maintenance activities consist of weed control, pruning, nutrient management, and irrigation management for magnificent growth of the plantation in order to sustain the aesthetic of the green wall system.

Besides, there has a category of green wall maintenance known as regular maintenance. It is a routine or periodic maintenance. By conducting regular maintenance, the recurrent and repetitive maintenance activities such as pruning, trash removal, and weeding would be carried out to ensure the green wall system is maintain in a satisfactory image.

In addition, cyclic maintenance is the maintenance activity that is scheduled less often than regular maintenance. The maintenance is carried out for the green wall components contact with the building wall and structure of building itself in order to ensure the vertical green wall structure is secure and meet the safety standards.

Not only that, but there has also reactive and preventative maintenance. This category of maintenance is conducted when there is any part of system break down or it is detected there has a sign of failure of the green wall system. It is also referring to measure undertaken towards the green wall system in case of sudden damages happened. Usually, the failure of green wall system is result from the bad weather and the long-term issue which is unnoticed such as weeds or roots block the drainage system.

Apart from that, another category of green wall maintenance is renovation maintenance. It is a maintenance work which involves activity of changing the existing design of green wall system. It is carried out when the ownership of building has changes or even there has a situation of failure of design and installation of green wall system.

2.5 Issues of Vertical Green Wall Maintenance

First of all, a famous French botanist, Dr. Patrick Blanc indicated that one of the issues of maintenance works for green wall building is difficult to be accessed and carried out. With this, he highlighted that the vertical greenery must be more sustainable compared to other types of green infrastructures in order to assure that the lifecycle of green wall can last for many years (Twenty6 Magazine, n.d.).

Moreover, according to The Straits Times (2016), Dr. Patrick Blanc depicted that without the idea and knowledge to execute the maintenance of green wall would results to the dying of plantation on the vertical wall. In fact, it has the situation where majority of the management teams or gardeners are lack of experiences on implementing the maintenance of green wall as well as they have no specific techniques to execute in maintaining the vegetation installed on the building wall surface (Peck, et al., 1999).

Furthermore, green wall system is involving the issues of fall protection and safety assessment in execution of maintenance works. It is lack of technical information related to the green wall compared to the rooftop greenery. This situation might lead to the uncertainties problem of the implementation of maintenance works for green wall system. Consequently, the safety measure

or site risk assessment could not be conducted priory for the maintenance works of green wall building and thus result to the existing of safety risk (Behm & Hock, 2012).

Besides, according to the opinion of architectural, the application of green wall system is less than the installation of green roof system because it requires greater implementation of maintenance in green wall compared to the rooftop greenery (Singh et al., 2017). The green wall system that involving the elements such as vegetation, irrigation system, drainage system, growing media, and support system is important in every stage of installation, replacement, and maintenance of it. With this, there would be more maintenance considerations on the green wall system as it needs much more execution of maintenance activities such as preservation and replacement on those systems and vegetation across the wall (Manso & CastroGomes, 2014; Chew & Conejos, 2016).

In addition, the cost of maintenance is also considered as the issue of green wall maintenance. It is requiring high maintenance cost for the activities of piping and pruning as well as the replacement species of plantation and panels systems of the green wall (Rakhshandehroo et al., 2015). The maintenance works for the activities such as management of irrigation system, pruning the vertical vegetation across the wall using the boom lifts, substitution of plantation and panels structures, disposal of fallen leaves and so on are the costly activities for implementation green wall in term of maintenance (Mir, 2011). The cost of its construction and maintenance is higher as it is required professional knowledge and technology for this field (Peng, 2013).

Table 1: Summary of Issues in Maintaining Vertical Green Wall

FINDINGS	AUTHOR
Hard to access the vertical green wall maintenance	Dr. Patrick Blanc (Twenty6 Magazine, n.d.)
Lack of knowledge and experiences in maintaining vertical green wall	Zachariah, N. A. (2016); Peck, et al. (1999)
Issue of safety risk in maintaining vertical green wall	Behm and Hock (2012)
Required many maintenance work process or activities for vertical green wall	Singh et al. (2017); Manso and CastroGomes (2014); Chew and Conejos (2016)
High cost in maintaining vertical green wall	Rakhshandehroo et al. (2015); Mir (2011); Peng (2013)

3. METHODOLOGY

This research study focused on the issues in maintaining the vertical green wall for real practices in Malaysia. In this study, sequential form of mixed model research design is applied. The combinations of qualitative and quantitative approach are used to produce the results findings for this study.

3.1 Data Collection

Firstly, the study is conducted to identify the issues in maintaining vertical green wall. The previous research findings are referred, and semi-interview survey is carried out with plantscape consultants of case study in order to achieve the objective one. The outputs from objective one also utilized for the input of questions in questionnaire survey.

Secondly, this research study is also carried out to analyse the ranking of the most important issue in maintaining vertical green wall. In order to fulfil the objective two, the questionnaire survey is executed to study the opinion of the property managers of selected case studies toward the most important maintenance issues for vertical green wall. With this, there are several types of buildings that implemented with green wall system which available in Kuching District and Kota Samarahan District in Sarawak, Malaysia are selected as case studies for this research study. There are five case studies selected for this research which are Roxy Hotel Padungan, Roxy Hotel Kuching, car-park building of Mercedes-Benz Hap Seng Star Sdn Bhd, corner lot of shop office building (Perinsuran Brokar Sdn. Bhd.), and 14-storey apartment tower of the Eden On The Park. The green wall buildings are managed by property managers whereas the maintenance works of green wall system are done by gardeners.

Source of data is categorized into two types which are primary data and secondary data. The secondary data is used to meet the research objective one. The literature review from several journals, magazines, and websites are utilized for data collection in this research objective one. Besides, the primary data used for this research objective one to collect data is semi-structured interview survey. Besides, the type of data used to achieve the objective two is primary data. The questions of questionnaire are based on the output from objective one and the questionnaire survey is distributed to the property managers of the selected green wall buildings based on the selected case study.

The secondary data collected of literature review for this study consists of journals, articles, thesis, magazines, and websites from Universiti Teknologi Malaysia Online Database. The semi-structured interview survey is conducted with the property managers or plantscape consultants of the selected case study of Roxy Hotel Padungan which is located at Kuching District at Sarawak, Malaysia. The virtual interview is carried out because of implemented of movement control order in Malaysia due to pandemic COVID-19 outbreaks at the mid stage of data collection. English language is used for interview session in order to align with the language for this paper of study.

The set of questionnaires is designed with the questions related to the issues in maintaining the green wall. The questionnaire surveys are distributed to the property managers who manage the vertical green wall buildings according to the case studies selected. It would be carried out in English language and the survey is aimed to collect the opinions from the green wall building management perspective which related to the rank of the most critical issues of vertical green wall maintenance. The questionnaire survey is divided into three sections which are section A, B and C. The section A is obtained the information of the respondents such as the gender, age, highest level of education and year of working experiences. Questions in section B are involved the general information of green wall building. The section C consists of the questions related to the issues of implementation of maintenance green wall buildings. The source of question

in section C is from the output of the first objective which is through the literature review and interview survey in related to the maintenance of green wall building.

3.2 Data Analysis

The data collected for the first objective is analysed using systematic review analysis and descriptive analysis. A systematic review is a research method that used to identify and review the pertinent research as well as collect and analyse the data from the research. The purpose of this method is to investigate the verifiable evidence that meets the inclusion criteria in order to answer the research question and achieve the research objective (Snyder, 2019). In this study, the data includes definition, classification of green wall and issues in maintaining vertical green wall are obtained by referring the previous findings of study with systematic review analysis. Moreover, the data obtained from the interview survey is analysed by descriptive analysis. It is used to elaborate the information collection in this study. The data is explained in description forms to meet with the opinion from the interviewees.

The data collected for second objective is analysed using frequency analysis that has been collected from the questionnaire survey. Frequency analysis is an organized graphical or tabulation form that representing the number of individuals on the scale of measurement which allow researchers to be able to review the entire data collected conveniently (Manikandan, 2011). The data collected from the questionnaires gathered from the respondents are analysed to disclose the results. The results are interpreted in tabulation and graphical forms as well as with the summarize description.

4. RESULT AND DISCUSSION

4.1 Issues in Maintaining Vertical Green Wall

The first objective is to identify the issues in maintaining vertical green wall. There are several issues in maintaining vertical green wall. It is identified by using systematic review analysis from previous studies. The interview survey is also adopted, and the data collected is analysed using descriptive analysis to fulfil the first objective.

Table 2: Issues in Maintaining Vertical Green Wall based on Systematic Review Analysis

FINDINGS	AUTHOR
Hard to access the vertical green wall maintenance	Dr. Patrick Blanc (Twenty6 Magazine, n.d.)
Lack of knowledge and experiences in maintaining vertical green wall	Zachariah, N. A. (2016); Peck, et al. (1999)
Issue of safety risk in maintaining vertical green wall	Behm and Hock (2012)
Required many maintenance work process or activities for vertical green wall	Singh et al. (2017); Manso and CastroGomes (2014); Chew and Conejos (2016)
High cost in maintaining vertical green wall	Rakhshandehroo et al. (2015); Mir (2011); Peng (2013)

From the Table 2, it can be summarised that there are several issues in maintaining vertical green wall from previous studies. Firstly, Dr. Patrick Blanc mentioned that the green wall maintenance work is hard to access, and it is required to be carried out the maintenance works as to assure the green wall lifecycle can be last for long period and become sustainable compared to other types of green infrastructure (Twenty6 Magazine, n.d.). In addition, there has an issue of lack of knowledge and experiences in maintaining the vertical green wall (Zachariah, 2016; Peck, et al., 1999). Moreover, the safety issue is one of the issues in maintaining vertical green wall as compared to green roof (Behm & Hock, 2012). Furthermore, there is an issue of requiring many maintenance work process or activities for vertical green wall. Green wall system involves with vegetation, irrigation system, drainage system, support system, growing media and others which requires more maintenance considerations such as preservation and replacement of those elements installed to the wall of building. From this, it requires many process or activities in maintaining vertical green wall (Singh et al. 2017; Manso & CastroGomes, 2014; Chew & Conejos, 2016). Besides, high maintenance cost is also considered as one of the issues in maintaining vertical green wall (Rakhshandehroo et al., 2015; Mir, 2011; Peng, 2013).

Table 3: Issues in Maintaining Vertical Green Wall based on Interview Survey

Case Study: Roxy Hotel Padungan	
Question	Based on your experience, what is the common issues that might happen during green wall maintenance?
Interviewee's Answer	a) Safety issue of the workers. It is always the most concerned issue in the green wall implementation and maintenance works. Whatever we go up to three meters, once you fall down, that would be an issue. So, we need to be careful when we carry out these maintenance works. b) Cost and budget of the company. (Roxy Hotel Padungan)

According to the experience and opinion of interviewee, safety issue of workers is one of the common issues in maintaining vertical green wall. This issue is always being the most concerned matters during the installation and maintenance of vertical green wall. Besides, the cost and budget of company in maintaining green wall system is also one of the issues because it costs high meanwhile it has to be conducted few times in a year.

4.2 The Most Important Issues in Maintaining Vertical Green Wall

The second objective is to analyse the most important issues in maintaining vertical green wall. Questionnaire survey is carried out based on the property managers of the case studies in Kuching District and Kota Samarahan in Sarawak, Malaysia. It is identified by using frequency analysis.

Table 4: Ranking of Important Issues in Maintaining Vertical Green Wall

ISSUE	MEAN	RANK
Safety issue	4.6	1
High maintenance cost	4.4	2
Hard to access vertical green wall maintenance	3.4	3
Lack of knowledge and experience in maintaining vertical green wall	3.2	4
Required many maintenance work process or activities	3.0	5

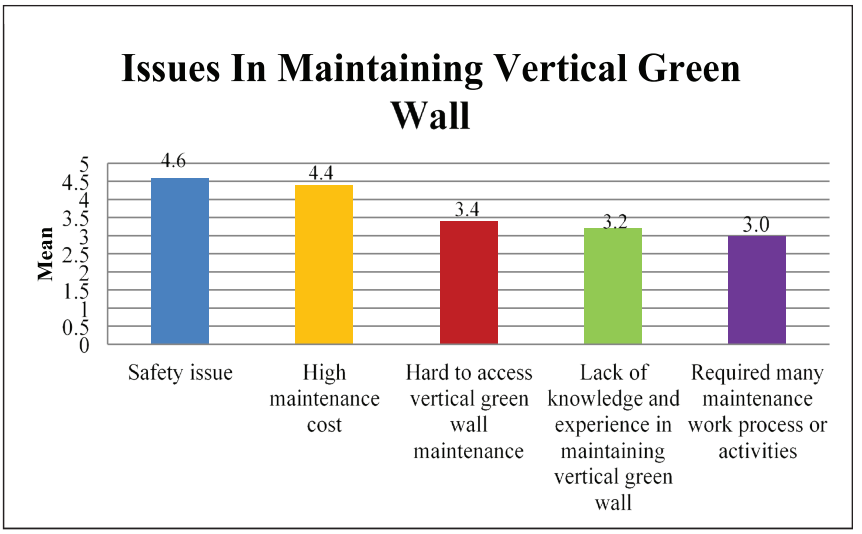

Figure 1: Important Issues in Maintaining Vertical Green Wall

Table 4 and Figure 1 shows the ranking of important issues in maintaining vertical green wall. Based on the table above, the highest rank of issue in maintaining vertical green wall is 'safety issue' with mean value of 4.6. The second and third highest rank of issues is 'high maintenance cost' and 'hard to access vertical green wall maintenance' with the mean values of 4.4 and 3.4, respectively. The issue of 'lack of knowledge and experience in maintaining vertical green wall' is ranked at number 4 with mean value of 3.2. The mean value of issue of 'required many maintenance work process or activities' is 3.0 which ranked at the lowest ranking.

4.3 Index Range of Important Issues in Maintaining Vertical Green Wall

After ranking the issues in maintaining vertical green wall as results shown above, index range is determined to figure out the scale of important level of issues in maintaining vertical green. The formula is as follow:

$$\text{Index range} = \frac{\text{Maximum mean value} - \text{Minimum mean value}}{\text{Number of scale categories}}$$

By referring to the index range formula stated above, the index range of issues in maintaining vertical green wall is calculated as follows:

$$\text{Index range for issues in maintaining vertical green wall} = \frac{4.6 - 3.0}{5}$$

$$= \mathbf{0.32}$$

The maximum and minimum of mean value for the important issues in maintaining vertical green wall are 4.6 and 3.0, respectively. Thus, the index range calculated for important issues in maintaining vertical green wall is 0.32.

Table 5: Index Range for Important Issues in Maintaining Vertical Green Wall

CATEGORY OF SCALE	RANGE OF MEAN VALUE
Very Important	4.28 – 4.60
Important	3.96 – 4.27
Moderately Important	3.64 – 3.95
Slightly Important	3.33 – 3.63
Not Important	3.00 – 3.32

The Table 5 displays the index range for important issues in maintaining vertical green wall according to their scale category. The results show that the range of mean value from 4.28 to 4.60 is 'very important' issues in maintaining vertical green wall. The 'important' issues in maintaining vertical green wall is in range of mean value from 3.96 to 4.27, meanwhile the range of mean value among 3.64 to 3.95 is 'moderately important'. However, the mean value between ranges of 3.33 to 3.63 is 'slightly important' issues in maintaining vertical green wall and the mean value in range of 3.00 to 3.32 is considered as 'not important' issues in maintaining vertical green wall.

4.4 Rescaling of Important Issues in Maintaining Vertical Green Wall

Rescaling is required to be carried out based on the range of mean value that has been calculated in order to identify the important level of issues in maintaining vertical green wall. Therefore, the table below indicates the entire rescale for important issue in maintaining vertical green wall which is according to their mean value.

Table 6: Rescale of Important Issues in Maintaining Vertical Green Wall

ISSUE	MEAN	SCALE
Safety issue	4.6	Very Important
High maintenance cost	4.4	Very Important
Hard to access vertical green wall maintenance	3.4	Slightly Important
Lack of knowledge and experience in maintaining vertical green wall	3.2	Not Important
Required many maintenance work process or activities	3.0	Not Important

The Table 6 shows that the rescale for important issues in maintaining vertical green wall which based on their range of mean value. The safety issue and high maintenance cost is recorded under level of 'Very Important' as the mean value are 4.60 and 4.40 respectively which is in between the range of 4.28 to 4.60.

Followed by the 'Slightly Important' level which is hard to access vertical green wall maintenance has the mean value of 3.4 is recorded in between the mean value range from 3.33 to 3.63. Moreover, issues of lack of knowledge and experience in maintaining vertical green wall, and required many maintenance work process or activities are recorded in the range of mean value from 3.00 to 3.32 and thus considered as 'Not Important'.

5. CONCLUSION

In conclusion, this research has fulfilled the research objectives. However, there has limitation of respondents for this study. In fact, the case studies selected for this study is only in the scope of Kuching District and Kota Samarahan District, Sarawak, Malaysia. With this, future study should involve more case study or respondents by expand the scope of areas for the study. Besides, the data collection is also conducted through online platform with limited respondents due to the implementation of movement restriction order. By this, future study has to involve with many respondents with experiences of professionals such as property managers, plant scape consultants, property engineers, property architects. There are some implications of study which could be redounding to three parties. The result findings could enhance the knowledge and efficiency of property managers towards the green wall maintenance. Moreover, the research also contributes to building designers and professionals that provide an overview to develop well in implementation of the vertical green wall projects. Furthermore, the findings of this study also make contribution to future researchers who are interested to further explore this related field of topics.

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