Abstract: Property investment is always enticing, especially the high-rise residential property. The promise of the raising future value of it keeps investors attracted. Urbanisation also contributes to the massive development in this business, and it is hardly ignored. To run the business and to be able to compete with others, developers have to keep the cost attracted for the residents/buyers. The property needs to be well designed to satisfy the economical capital expenditure as well as low operation and maintenance cost. The high density of this development in an urban area makes developers tend to have low awareness of practising sustainability. Inconsistent evaluation, as well as unwell-defined assessment for sustainability, worsen the situation. This research aims to investigate and develop performance evaluation criteria of sustainability for high-rise residential building. Both qualitative and quantitative approaches were implemented through surveys. Three main factors, which are the promotion of a healthy environment, comfortability of residents and energy-saving, found to be the main categories of criteria to be considered. Based on validation through a case study, it is found that providing easy access to public transport is the most critical criteria for promoting a healthy environment. Besides, the usage of low Volatile Organic Compound (VOC) paint can give comfort to residents because it provides healthy indoor air quality. Lastly, the usage of LED bulbs and natural light supports energy saving. The criteria are then used to develop the decision-making model in selecting the best alternative for the building refurbishment, by using Analytical Hierarchy Process (AHP). Application of the decision model in a case study reveals that repainting the building using low VOC paint become the best fit option for enhancing the environment. Developers may implement this in their policy for the redevelopment of their building. The result is limited to the aggregation value; thus, future research is directing into coalition and negotiation among stakeholders by applying payoff optimum and agreement options and also automation in selecting the best technical solution.

Keywords: sustainable building design; refurbishment; building maintenance; design criteria

1. Introduction

The concept of environmental enhancement has rapidly grown nowadays, especially in property development. Responsibility to allow future generations to receive the benefits and reduce the negative impacts of the development becomes the goal. The concept of environmental enhancement is needed to be adopted in achieving the balance of interaction between the environment and development [1]. Previous studies highlighted a few issues related to the performance of high-rise residential buildings and their environmental enhancement practices. It has been observed that the level of environmental enhancement practices among property companies in Southeast Asian countries, including Malaysia,
is very low due to lack of awareness about green practices [2]. Besides, the tenants or residents of the residential favour a good performance from property management companies in term of maintenance and facilities [3]. There is also a problem in maintaining the building performance by property companies. It was revealed that the building maintenance also could not achieve the standard level of performance [4]. Razali et al. [2] also found the necessities of environmental enhancement practices through high-rise building refurbishment. Additionally, a high density of development in urban planning also becomes a major issue. This is because when the development is grown too fast, it can affect the evaluation of quality and performance of the buildings. Thus, it is crucial for public safety and health [5].

Looking at the urgency, the environmental-friendly refurbishment indeed becomes vital. Although it requires pretty much budget to realise, the project stakeholders see the benefit of it for the health, environment, and economy. It contributes to the enhancement of the environment and also has a positive impact on social and economic. It may save the local community as well as enhance the economic value of the building and its surrounding [6]. It is also found that the residents are aware of the benefits of refurbishment and willing to spend their money on it. This study aims to investigate the performance evaluation criteria, as well as possible alternatives for enhancing the quality of the environment, particularly for the high-rise residential building in Malaysia. A case study has also been conducted to validate the result.

2. Literature Review

2.1. Sustainability of Property Development in Malaysia

Environmental enhancement aims to avoid the decreasing of natural resources and maintain the ecological balance for the future generation. The environmental enhancement concept becomes essential in many industries, including property development. It increasingly plays a vital role. Malaysia has initiated the environmental enhancement initiatives for building by implementing Green Building Index (GBI) rating system [1]. The trend of green concept especially in residential property accelerates throughout the year due to the introduction of GBI. Malaysia also has launched a National Green Technology Policy (NGTP) in 2009, with the purpose to implement green initiatives in Malaysia. NGTP offered several green incentives including green technology research and innovation, promote public awareness in green practices, application of energy efficiency and GBI [1]. Sood et al. [7] stated that the National Policy on Climate Change also highlighted the importance of sustainable development in Malaysia through the commercial sector. However, there is still much room for improvements to ensure green technology to become a practice among property development [8].

2.2. Previous Studies of Environmental Enhancement and Building Refurbishment

Previous studies were reviewed and mapped. The similarities and differences of issues are presented in Table 1 and illustrated in Figure 1.

| Problems                  | Similarities                                                                 | Differences                                                                 |
|---------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|
|                           | 1. Low sustainability practices levels among property companies               | 1. High development density in urban planning                                |
|                           | 2. Need improvement of sustainability in property development                | 2. Lack of well-defined indicators of evaluation criteria                    |
|                           | 3. Maintenance does not achieve the standard                                 | 3. Low in awareness among the property companies                             |
|                           | 4. Residents favour good performance                                         |                                                                              |

Table 1. The similarities and differences of the previous studies.
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Figure 1. The similarities of findings from previous studies (Sources: 1 = Chua et al. [4]; 2 = Ho and Liusman [9]; 3 = Razali et al. [1]; 4 = Razali et al. [2]; 5 = Yau et al. [5]; 6 = Lorenz and Lützkendorf [10]; 7 = Meistad [3]; 8 = AboMoslim and Russell [11]; 9 = Sia et al. [12]; 10 = Yau et al. [13].

One of the criteria that were highlighted is building maintenance. Chua et al., [4] investigated the maintenance practices in high-rise residential building to ensure the constant and efficient usage of the building system and their components. The particular research aimed to determine the maintenance characteristics and evaluate the impact of the maintenance performance of high-rise residential building in Klang Valley area. The main reason for concerning the building maintenance is because of the output of the maintenance strategy could not achieve the standard level of performance. Four characteristics were investigated, which are skills of workers, spare part and material, a planned interval for maintenance, and also maintenance downtime. Those criteria were examined in high-rise residential buildings with a minimum of seven floors, age of not less than 5 years and provide facilities that require maintenance, such as the elevator, CCTV and swimming pool. The results showed that all those four characteristics influence maintenance performance. Findings gained from reviews to previous studies are thoroughly explored and synthesised in Sections 2.2.1–2.2.4.

2.2.1. The Performance Evaluation of Property Management Companies in High-Rise Apartment

Ho and Liusman [9] measured the performance of property management companies in managing high-rise residential buildings. The performance was determined by using the logic model as the contextual framework with the indicator taken from the Building Quality Index (BQI). The approach of this research was done by doing a visual inspection and conducting interviews with building managers and staffs regarding the performance outcome. The outcomes were varied based on the sample of 41 different high-rise residential building in early 2013 located in Hong Kong. The inspections covered structure and building fabric condition, building services condition, condition of exit route, lift, common areas such as walls and corridor and covered bins. A study found that the performance outcomes of the logic model can help the residents and management to have a deep understanding in the current performance of their residential building and help to develop strategies to enhance safety and health of the residential buildings in future. Most of the considerations are related to the performance of facility management, as can be found in [14]. Consideration of the appearance and performance of communal space is also highlighted by [15]. Both [9] and [16] concern building safety as one of the vital measurements for the performance.
2.2.2. The Performance Evaluation of Sustainable Property Development by Malaysian Property Companies

Razali et al. [1] assessed the level of sustainability practices among property companies in Malaysia. The level of sustainability practices by property management companies in Malaysia was assessed by using content analysis, company annual reports and websites. The sustainability strategies were also being examined by using an attributes scorecard. The results showed that the sustainability practices among the property companies in Malaysia are still at a low level. This situation proved that there is a need for improvement. The assessment also indicated that only 12 developers were able to meet more than half of the sustainability criteria in the attribute scorecards out of 79 developers in Malaysia. This reveals that only 15 per cent of the listed property companies were serious in applying the sustainable concept in their development. Ahmed et al. [17] suggested that these companies should have an effective environmental audit system to compromise the elements of environmental policy and reporting system. Following this, Newell [18] suggested several measures to practice sustainable development such as the use of power green sources and green leases. Sustainability can also be achieved by applying low or zero energy concepts in design, retrofitting of efficient ventilation, cooling and lighting systems and practice of energy conservation in buildings.

2.2.3. The Performance Evaluation of Sustainable Property Development by Southeast Asian Property Companies

The level of sustainability practices among public-listed property companies in Southeast Asia was also investigated [2]. The scope is limited to only five Southeast Asian countries, which are Singapore, Malaysia, Thailand, Indonesia and the Philippines. To determine the sustainability level, the method used was by assessing companies’ websites and annual reports. The sustainability was determined by using scorecards. It was observed that sustainable development in those Southeast Asian countries remains at a moderate level. One of the reasons is because there is no consistent sustainability evaluation due to a lack of well-defined indicators for assessment. Hence, it is essential to determine the criteria to enhance the level of sustainability attributes in property development. Several kinds of research have highlighted the needs of sustainability, for instance, Newell [18] stated that one of the best sustainability practices in property development is the use of sustainable power sources. Sixteen attributes of sustainability were compiled to rank the level of sustainability practices, which are the awareness of sustainability, sustainability in corporate social responsibility (CSR), environmental issues, policy in sustainability, sustainability awards, and green-friendly projects. The findings show that only a few companies were able to fulfil the sustainable parameters. The study revealed that there were only eight companies that almost achieved the perfect score. In terms of percentage score, none of the attributes was able to achieve more than 50 per cent of the companies as the highest was only 43 per cent. It can be concluded that more than half of the listed property companies need to show their interest in participating sustainable practices.

2.2.4. Estimation for Predicting the Performance of Private Apartment Buildings

Yau et al. [5] found that the evaluation of the quality and performance of an apartment in Hong Kong is crucial for public safety and health. There are a lot of high-rise apartments in Hong Kong due to the limitation of an area in facilitating big population. Similar to [9], the study proposed a statistical approach for a fast and reliable building evaluation algorithm using the Building Quality Index (BQI). One hundred thirty-three of private apartments in Yau Tsim Mong and 160 private apartments in Eastern District were assessed. After the assessment, the developers face difficulties in deciding the building will be rehabilitated or refurbished, thus multicriteria decision making for evaluating urban regeneration project has been developed [13]. Jeffrey and Pounder [19] also concerned the difficulties in deciding urban regeneration project and highlighted that the most essential element is the physical improvement. Based on the study, the project can be evaluated based on 16 criteria that are grouped under four categories, which are economic, environmental, physical and social. Similar to [14],
this study also measured the satisfaction of residents toward the building’s facilities. It was also found that residents prefer to live in a new apartment compared to the old apartment, because of the attractive facilities, particularly the green communal space.

3. Methodology

The research flow is illustrated in Figure 2. Triangulation methodology was applied to integrate the simultaneous and sequential of qualitative and quantitative approaches. There are two main surveys and data analysis. The research started with grounded theory to develop the hypotheses and research conceptual background through reviews of the current performance evaluation for high-rise residential building from previous studies, as well as an interview to developers and residents. The criteria and technical solutions are presented in Table 2. It continued with the 1st survey to investigate the performance criteria and to evaluate and determine the best strategies to improve sustainability in high-rise residential building. Interviews were also carried out to explore and validate the essential criteria. Scatter plot of mean and standard deviation was utilised to analyse data from the 1st survey and identify the technical solution for the environment enhancement. Three technical solutions were found as representative of the most technical solutions from each criterion. The technical solutions were determined as the decision alternatives for the second survey. AHP methodology was applied for the second survey with the main purpose to select the best strategy (technical solution). A case study was also conducted to validate the result on the medium-cost apartment. Three stakeholders were involved in the second survey. AHP is a systematic method that presents various problems in the form of a hierarchy [20]. The output of the AHP analysis can provide a reference for the methodology and evaluation of the research model [21]. AHP was used because it is not only based on specific research data and analysis, but also involve people who are experts in the related topic [22]. This method was also used to develop strategies for sustainable energy planning in Pakistan [23,24].

Figure 2. Research flowchart.
Table 2. The factors and its technical solution mentioned in the questionnaire.

| Criteria 1: Healthy Environment | Criteria 2: Comfortability of Residents | Criteria 3: Energy Efficiency |
|---------------------------------|----------------------------------------|-----------------------------|
| Technical solutions for achieving a healthy environment | 1. Allow long distance view to reduce eyestrain [27] | 1. Usage of LED bulbs [28–31] |
| 1. Provision of the green communal area [15,25,26] | 2. Provision of daylight control to reduce the discomfort of glare [33] | 2. Usage of natural light [3,8] |
| 2. Provision of easy access to public transport [32] | 3. Provision of flexible lighting control and motion sensor [36,37] | 3. Provision of quality air filtration  |
| 3. Provision of water recycling system [34] | 4. Provision of proper ventilation [3,8] | 4. Usage of the solar panel [3,4,7] |
| 4. The implementation of rainwater harvesting and filtration of greywater [38] | 5. Usage of low VOC paint [39–41] | 5. Usage of EnergyStar appliances [42] |

4. Results and Discussions

4.1. Environment Enhancement Evaluation Factors

A pilot study was conducted to review and confirm the criteria. The survey was done to investigate and develop performance evaluation criteria for high-rise residential property. The background of the respondents is presented in Table 3. The criteria have been categorised into three main categories, which are to promote a healthy environment, comfortability of residents and energy efficiency. Furthermore, the respondents were asked to evaluate the criteria for all three main factors to achieving sustainability in high-rise residential building, as shown in Table 4. The level of importance of each factor is evaluated based on its support in achieving sustainability. Each of the criteria has a set of technical solution. This technical solution was evaluated by a scatterplot of mean and standard deviation. Subsequently, the most prioritised technical solution of each criterion became the decision alternative.

Table 3. Background of respondents.

| Items                      | Sub-Items         | %   |
|----------------------------|-------------------|-----|
| Working experience in construction project | High rise residential | 46  |
|                            | Low rise residential | 14  |
|                            | Others            | 40  |
| Experience in living high-rise residential | <3 years         | 31  |
|                            | 4–8 years         | 25  |
|                            | 9–15 years        | 19  |
|                            | >15 years         | 25  |

4.2. Technical Solution as Decision Alternatives

Some potential technical solutions for the building refurbishment in enhancing the environment were identified. The use of water recycle enhances the environment, but the realisation of this approach is quite challenging because of the low level of public awareness [34]. Another essential technical solution is the provision of a pedestrian path, particularly in urban environments [32]. The factors that influence pedestrian path are land use, pedestrian activity and pedestrian volume. Things that must be considered for designing a pedestrian path are road designs that are safe for pedestrians. Towards to environmental enhancement, the high-rise building also needs to reduce the content of Volatile Organic Compound (VOC) as paint, which is an organic compound that harms the health of the occupants [39]. The impact of VOC paint on human health includes skin irritation, dizziness, fatigue and the most severe is damage to lung function. Room air quality is also affected by VOC emissions on walls and vents. Effective air circulation can reduce emissions from VOC. Previous studies suggested the utilisation of VOC paint should be no more than 30 mg/L [40,41].

Environmental enhancement can also be achieved by reducing building energy. Light Emitting Diodes (LED) are semiconductor electronic components that emit electromagnetic radiation. LED bulb...
has advantages over conventional lamps because they do not contain mercury and ultraviolet (UV), so the LED bulb does not have a bad impact on human health [28]. LED bulb can also save energy effectively [29], and it can also be recycled. As capital expenditure in the investment, the LED bulb has a high price compared to conventional lamps [30], but the operation and maintenance costs are lower. Installing LED bulb in every room will save energy [43]. Therefore, innovation is needed to minimize the use of lighting. Previous studies also suggested that motion sensors can be utilised to support the effective use of lighting [31,36,37].

### Table 4. The rank of the technical solution from scatters plot of Mean and SD.

| Criteria             | Technical Solution                                                                 | Mean | SD  | Rank |
|----------------------|-------------------------------------------------------------------------------------|------|-----|------|
| Healthy Environment  | Provision of easy access to public transport                                        | 4.40 | 0.67 | 1    |
|                      | Provision of water recycle system                                                   | 4.43 | 0.68 | 2    |
|                      | Provision of an adequate area of park and landscaping with greenery plants          | 4.33 | 0.71 | 3    |
|                      | The implementation of rainwater harvesting and filtration of greywater              | 4.23 | 0.63 | 4    |
| Comfortability of Residents | Usage of low VOC paint                                                            | 4.40 | 0.62 | 1    |
|                      | Provision of proper ventilation                                                     | 4.33 | 0.66 | 2    |
|                      | Usage of quality air filtration                                                     | 4.27 | 0.64 | 3    |
|                      | Provision of daylight control to reduce the discomfort of glare                     | 4.13 | 0.73 | 4    |
|                      | Allow long distance view to reduce eyestrain                                        | 4.17 | 0.83 | 5    |
| Energy Efficiency    | Usage of LED bulbs                                                                  | 4.53 | 0.62 | 1    |
|                      | Usage of natural light                                                              | 4.5  | 0.63 | 2    |
|                      | Provision of flexible lighting control and motion sensor                             | 4.5  | 0.63 | 3    |
|                      | Usage of solar panel                                                                | 4.53 | 0.73 | 4    |
|                      | Usage of EnergyStar appliances                                                      | 4.37 | 0.81 | 5    |

Table 4 presents the result of mean-standard deviation analysis for the technical solutions from the 1st survey. Following the analysis, all the technical solutions can be ranked based on their priority in supporting environmental enhancement through building refurbishment. Provision of easy access to public transport is found as the most influencing factor to support environmental enhancement through the achievement of a healthy environment. On the other category, the usage of low VOC paint for refurbishing the high-rise residential building becomes the highest influencing factors in achieving comfortability of residents and enhancing the environment. The usage of LED bulbs also has capability in enhancing the environment through the achievement of energy efficiency criteria.

### 4.3. Evaluation of Best Alternative Using AHP

A second survey was conducted using a set of questions for Analytical Hierarchy Process (AHP) and three interviews with professionals to evaluate the alternatives and select the most critical criteria and best alternative. The AHP questionnaire has been distributed to high-rise residential building developers in Malaysia. In this study, based on the three preferences of stakeholders, a weight for each evaluation criteria were generated and a score to each option was assigned accordingly. A higher score reflects the better performance of the alternative. Figure 3 shows three levels of decision hierarchy. The goal of the problem (select the best fit option for environmental enhancement through high-rise building refurbishment) is addressed by some alternatives (A = a1; a2; a3), which are the provision of easy access to public transport; repaint using low VOC paint; and also change to LED bulbs and add motion sensor, respectively. Three evaluation criteria were used to select the best technical solution. The evaluation criteria are c1; c2; c3. Afterwards, the AHP was started with judgment and synthesis. The best alternatives among stakeholders are determined by conducting judgment and synthesis. Three steps need to be done sequentially. First is determining the weighting factor (weight of preferences)
of criteria for each stakeholder (Figure 4). Second is grading alternative for each evaluation criteria (Figure 5), and third is scoring every alternative for every stakeholder (Figure 6). Based on AHP, the relative importance of pair-wise comparison of decision input could be equal (1), moderate (3), strong (5), very strong, demonstrated (7) or extreme (9). Sometimes one needs to compromise judgments (2; 4; 6; 8) or reciprocal values (1/9; 1/8; 1/7; 1/6; 1/5; 1/4; 1/3; 1/2). If there are “n” items that need to be compared in a given matrix, a total of $n(n - 1)/2$ judgments are needed. There are two judgments involved in this decision—the first is criteria judgment for each decision-maker and the second, technical solution judgment for each criterion. Figure 4 presents the result of the first step in determining the criteria. It can be observed that each stakeholder has different preferences in decisions for environmental enhancement. Stakeholder 1 (SH1) considers the priority on the comfortability of residents. Meanwhile, Stakeholder 2 (SH2) concerns on energy efficiency and Stakeholder 3 (SH3) prioritises a healthy environment. This difference is due to the different background of interest. This difference is a natural character of decision making. These considerations will differentiate the options for a technical solution. The result from the second step is presented in Figure 5. Each criterion has a different priority for a technical solution. For energy efficiency, the alternative change to LED bulb (a3) is the main one, followed by the provision of easy access to public transport (a1) and finally repaint using low VOC paint (a2). For the comfortability of residents, the alternative a1 is of utmost importance. For a healthy environment, alternative a2 can be achieved primarily. This result is interesting because each alternative is given top priority for different criteria. The third step or the final step in determining the best choice is presented in Figure 5. There are different choices for each stakeholder. Figure 5 also presents the aggregated value of the three stakeholders. SH2 and SH3 chose a2 as the main choice in improving the environment for high-rise building developments. Meanwhile, SH1 chose a1. This choice is reasonable because from the start the three stakeholders have different criteria priorities. There are several methods of determining mutual choice, first with aggregation value [44], second by negotiation using coalition algorithm [45]. The second method is based on the optimum payoff for each stakeholder. In this paper, a joint choice is presented using aggregated values.

The best fit option for environmental enhancement through high-rise building refurbishment

Figure 3. Decision hierarchy for environmental enhancement.

4.4. Empirical Validation and Managerial Implications

All criteria used to evaluate the high-rise residential building in supporting the environmental enhancement were evaluated; however, the most critical criteria from all elements are discussed based on the perspective of respondents. The validation has been conducted through a case study using a focus group discussion to verify its applicability in current construction practice. During the session, managerial implications were also identified and developed. The results are presented in Table 5.
The three stakeholders have different criteria priorities. There are several methods of determining mutual choice, first with aggregation value [44], second by negotiation using coalition algorithm [45]. The second method is based on the optimum payoff for each stakeholder. In this paper, a joint choice is presented using aggregated values.

**Figure 4.** The priority of criteria of environmental enhancement for each stakeholder.

**Figure 5.** The priority of alternative for each criterion.

**Figure 6.** The priority of alternative for each stakeholder and the aggregation value.

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| Criteria                        | Previous Studies                                                                 | Justification and Implication                                                                 |
|---------------------------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Provision of easy access to public transport | Based on Meistad [3], residential buildings need to have environmentally friendly alternatives such as walking distance to a public transport hub and provide good facilities for pedestrians and bicyclists. These alternatives can reduce transport emission by employees and students on the daily travelling basis. | This factor was found empirically whereby the provision of easy access to public transport shall encourage the residents to reduce the usage of their transportation, thus, can reduce the carbon emission and avoid air pollution. |
| Usage of low VOC paint          | Based on AboMoslim and Russell [11], the purpose of using low Volatile Organic Compound (VOC) paint is to reduce the harmful emission from the paint into the environment. | The sustainable practice has been taken seriously by the developer including in choosing the paint as the developer purchase paint from suppliers' that consider the sustainability element such as low or zero VOC paint. |
| Usage of LED bulbs              | Razali et al. [1] stated that reducing the energy used can be the potential benefit in implementing sustainable development because it can cause low energy cost. | This factor was emphasized as it is 80% more energy-efficient and 25 times longer than a conventional bulb. |

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**Table 5.** Validation of Result and Managerial Implications.
Table 5. Validation of Result and Managerial Implications.

| Criteria                        | Previous Studies                                                                 | Justification and Implication                                                                 |
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| Provision of easy access to public transport | Based on Meistad [3], residential buildings need to have environmentally friendly alternatives such as walking distance to a public transport hub and provide good facilities for pedestrians and bicyclists. These alternatives can reduce transport emission by employees and students on the daily travelling basis. | This factor was found empirically whereby the provision of easy access to public transport shall encourage the residents to reduce the usage of their transportation, thus, can reduce the carbon emission and avoid air pollution. |
| Usage of low VOC paint           | Based on AboMoslim and Russell [11], the purpose of using low Volatile Organic Compound (VOC) paint is to reduce the harmful emission from the paint into the environment. | The sustainable practice has been taken seriously by the developer including in choosing the paint as the developer purchase paint from suppliers’ that consider the sustainability element such as low or zero VOC paint. |
| Usage of LED bulbs              | Razali et al. [1] stated that reducing the energy used can be the potential benefit in implementing sustainable development because it can cause low energy cost. | This factor was emphasized as it is 80% more energy-efficient and 25 times longer than a conventional bulb. |
Reviews to previous studies on the current performance of high-rise residential building indicated that most of the current buildings have the level of sustainability and support to environmental enhancement at a low or moderate level. There are just a few developers that take serious actions in the environmental enhancement on their development, which are the large developers. To increase the practice of sustainable development and refurbishment among the developers, the local authorities need to play their role to provide an indicator to measure the level of this practice in the project. Based on the results of this study, the criteria of sustainability will promote a healthy environment, provide comfortability to residents and support energy-saving to support the environmental enhancement endeavours. The highest weightage for healthy environment factor is to provide easy access to public transport. This criterion encourages the residents to reduce the carbon emission from transportation. This action not only leads to lower greenhouse gas emissions and air pollution that contributes to cost-effective [46]. The highest weightage for the comfortability of residents is found in the utilisation of low VOC paint [39]. It is validated that it provides healthy indoor air quality. As for achieving energy efficiency, the highest weightage is the usage of LED bulbs and natural light. By using LED bulbs, 80% more efficient energy use can be achieved and achieve durability 25 times longer than a conventional bulb. Furthermore, by managing the usage of natural light, energy consumption can be reduced and cause energy saving and low operation and maintenance cost [47].

Based on the case study that has been conducted to a medium-cost high rise residential building in Malaysia, it is validated that the medium developers do not pay attention in implementing all the criteria to achieve sustainable high-rise development, particularly in supporting the environmental enhancement. Access to public transport is provided, and it takes about 10 min to walk from the residence. Residential buildings need to have environmentally friendly alternatives such as walking distance to a public transport hub and provide good facilities for pedestrians and bicyclists. These alternatives can reduce transport emission by employees and students on the daily travelling basis. The buildings also do not use LED bulbs and cause the tenants to pay high maintenance cost. The buildings have more than a decade of age; thus, the developers have low awareness and knowledge in sustainability, especially in using low VOC paint. In comparison, large developers have already considered and implemented all these criteria in their development. The criteria also are required by the authorities. The analysis of data and results through AHP developed aggregation value among the three stakeholders and found the alternatives that have the highest value is repaint using low VOC paint. All the alternatives have been validated by experts from the large developers.

5. Conclusions

It can be concluded that it is important to consider an environmental enhancement concept in the property development industry. In general, the implementation of sustainability in property development able to reduce the environmental impact; therefore, it guarantees a better future to the next generation. From the perspective of residents in high-rise residential buildings, they agree that green practices can provide a better lifestyle in term of safety and health. Thus, the outcomes of this research can help property management companies and residents by providing the best alternatives and performance evaluation criteria for sustainable high rise residential. The three main factors were identified, which are a healthy environment, comfortability of residents and energy efficiency. Data analysis and application of the decision-making model through case study reveals that repaint using low VOC paint become the best fit option for refurbishing the building and supporting the environmental enhancement concurrently. This finding may give managerial implication and policy in refurbishing the high-rise building to enhance the environment. This result is limited to aggregation value. Further research on the coalition and negotiation among stakeholders by applying payoff optimum, agreement options and also automation in selecting the best technical solution is necessary to enhance the result.
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