Development of weightage for criteria affecting in retrofitting of existing building in Higher Learning Institution with clean energy initiatives

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Abstract. Campus university building is the Higher Learning Institution (HLI) involves complex activities and operations, conserving the energy has become paramount important. There are several efforts taken by universities to improve its current energy use such as policy development, education, and adaption of energy conservation solution through retrofitting. This paper aims to highlight the importance of the criteria affecting in retrofitting of existing buildings with clean energy in order to achieve zero energy balance in buildings. The focus is given to the development of criteria for solar photovoltaic (solar PV), wind turbines and small-scale hydropower. A questionnaire survey was employed and distributed to the green building expert practitioner. Factor Analysis, Factor Score, and Weightage Factor were adapted as a method of analysis in order to produce the final result with weightage output for prioritization and ranking of the relevant criteria. The result performed assists to provide the stakeholders an overview of the important criteria that should be considered especially during the decision making to retrofit the existing buildings with clean energy resources. The criteria developed are also to establish a structured decision-making process and to ensure the selection of the decision or alternatives achieve the desired outcome.

1. Introduction
The built environment is known as one of the most dominant contributors to the greenhouse gas emissions. There has been an encouragement to have an attention towards the needs of retrofitting which is upgrading the existing building stocks because it has significant potential in reducing the emissions, energy consumption and also the risk related to climate change [1]. The issue related to sustainability has become the crucial subject to discuss in many campus universities across countries [2]. Besides, campus sustainability also has been discussed worldwide especially by the policy makers and planners of universities since they discovered that the campus operation, activities, size, populations, and its physical structures have an impact to the environment. Since that, many governments and international organization have started to have an effort to improve the existing building energy efficiency through retrofitting [3].

Retrofitting in university building is one of the efforts that have the potential to increase the existing building condition to become energy efficient. University buildings is also a strategic selection to start with the implementation of retrofitting construction program in comparing with other public buildings [4]. Towards the realization to minimize the reliance of fossil fuels, there has been an increase in use of smart technology in a campus building that able to fulfil the real-life condition such as the implementation of daylight, energy efficient lighting and HVAC [5]. In addition, since the energy depletion issues are gaining attention, it has brought a great motivation to investigate the
sources from oil and coal, and to encourage building to utilize the renewable energy resources [6]. Despite implement the energy conservation, energy resources, and energy efficiency as strategies towards in achieving green building, it has been described that the reliance with the renewable energy is also considered as a big step to become a sustainable campus [7]. According to [8], eventually, people are encouraged to find the alternative to overcome the issue related to the fossil fuels supply which begins to dwindle. Thus, indirectly renewable energy has become the sources that should be considered or harness to transform it into energy. [9] Arguably that campus university building is described as a city but in a form of downscaled versions which has the biggest opportunity in exploring the currently available options to improve the inefficiency of energy use through the provision to use cleaner energy such as renewable energy.

2. The Implementation of Retrofitting in Higher Learning Institution

There are several studies conducted that covers the retrofitting of existing university buildings. The summary of the previous studies is presented in Table 1. Many studies have looked at different retrofitting strategies vary from lean energy (passive design), green technology and clean energy (renewable energy). Lean energy consists of initiatives such as improvement with the roofs, installation of skylights, replacement of existing windows, wall and roof insulation. For green technology, it varies from replacement of existing lighting, replacement of refrigerator, installation of VAV, VFD and occupancy sensors. Meanwhile, for clean energy it is mostly concern on the installation of solar photovoltaic. From the summary, it is also found that many retrofitting studies have much focused on the economic and environmental assessments. However, there is limited knowledge with the development of criteria for decision making in retrofitting. Therefore, this paper is to establish the important criteria for retrofitting of existing building that allows prioritization during the decision making the process by producing the Weightage Factor. The deliberation of this paper only focuses on the clean energy resources that consist of solar photovoltaic, wind turbines and small-scale hydropower.

| Retrofit Initiatives | Retrofit Initiatives | Area interest |
|----------------------|----------------------|---------------|
| University of Malaya [10] | Green | Energy consumption, operating cost, payback period, LCC |
| University of Mexico [11] | Green | Energy saving and CO2 emission |
| Melbourne University (Di Stefano, 2000) [12] | Green | Energy savings, payback time, NPV, cost of conserve energy |
| University of Seoul Korea [13] | Green +Lean | Reduction on energy consumption |
| Curtin University Sarawak [14] | Green | Annual energy and cost savings |
| Guangdong Colleges and Universities [15] | Green | Energy savings |
| Kingsville Texas University [16] | Green | Annual savings |
| University of Malaya [17] | Green | Energy savings and CO2emission |
| University of Mauritius [18] | Green | Energy saving |
| Stanford University [19] | Green | Energy saving and payback period |
| Highfield Campus of University of Southampton [8] | Clean | Energy consumption, capital cost, payback period, heat requirement |
| Hong Kong Universities [20] | Green +Lean | Energy saving, payback period, ROI and CO2 emission |
| University of Lagos [21] | Green | Energy savings |
| King AbdulAziz University [22] | Green | Power demand reduction |
3. Clean Energy

Clean energy, commonly known as renewable energy is an initiative adapted to attain for a more energy reduction in buildings [23]. Clean energy consists of several sources such as solar photovoltaic and wind power that has the ability in meeting the building energy demand. This clean source has a large contribution to reduce the greenhouse gas emission since it assists in reducing the reliance towards fossil fuels to generate electricity [24]. The implementation of clean energy is one of the provisions and become a vital initiative in order to have clean operation or production of buildings which contribute to less environmental impact [9]. According to [25], the generation of electricity based on fossil fuels which are used by most countries in this global is known to have a direct impact to the greenhouse gas emission and indirectly make the atmosphere warm. Therefore, clean energy resources that can be utilized in a variety of alternatives such as sun, water, and wind is believed will help to make a large reduction in greenhouse emission.

4. Criteria Affecting in Retrofitting of Existing Building

4.1 Solar PV

Solar PV is the innovation by using cells to capture solar energy that able to convert it into electricity. It can be installed whether in rooftops, land or integrate with building designs [26]. It has been widely accepted due to its features which has silent operation, low costs of operation and maintenance and does not produce pollution to atmosphere. Solar PV is able to be installed with two purpose, whether for new building or retrofitting but requires major consideration with the design [27]. Besides, solar PV is known as clean energy which is beneficial to achieve large reduction of carbon emission, no fossil fuels requirement, has a long-term of energy resources [28]. According to [29], solar PV is the technology that promises to achieve a great sustainable development since it helps to reduce the burden related to fossil fuels, carbon emission and also manage to fulfil the electricity demand. Figure 1 below shows the five (5) main criteria that has been developed towards considering the retrofitting of existing buildings in Higher Learning Institution with solar PV. It consists of design, PV features, management, economic and environmental criteria.

![Figure 1. Criteria Affecting in Retrofitting of Existing Building with Solar PV.](image-url)
4.2 Wind Turbine
Wind turbine is also known as a clean energy resource that currently has received attention by many due to realization to improve the environment [30]. Wind energy is also another alternative that able to reduce the reliance on fossil fuels and become a solution to the global ever-increasing energy needs [31]. According to [32], through the improvement of technology, wind turbine is currently reliable, efficient and cost-effective to be adapted in order to produce power. The ability of wind turbines to catch the air motion from natural wind to produce the rotational and electrical power does not create pollution or hazardous waste to the environment.

There are six (6) main criteria that have been established for the retrofitting of existing buildings with wind turbines. It covers on wind resource, management, economic, environmental, risk and design criteria as can be seen in figure 2.

![Figure 2. Criteria Affecting in Retrofitting of Existing Building with Wind Turbine.](image)

4.3 Small-Scale Hydropower
Hydropower is another renewable energy and clean source of energy which is also an initiative to reduce the countries’ dependency on fossil fuels [33]. Small-scale hydropower harness the small river and streams whereby the water will flow to the turbine component to generate the electricity. It has the ability to generate power from 5 Kilowatt to 100 Kilowatt, offers a high capacity which is about 50% compared to other renewable technology and has high efficiency at 70-90% which is considered as one of the best technologies (Nasir, 2014). According to [34], small-scale hydropower is operated with free from fuel, has a constant power for a long period and the power generated will increase during the rainy season.

Figure 3 below shows the establishment of main criteria and sub-criteria for the retrofitting of existing buildings with small-scale hydropower. It comprises of five (5) main criteria vary from site assessment, management, economic design, and environmental.
Figure 3. Criteria Affecting in Retrofitting of Existing Building with Small Scale Hydropower.

5. Methods
This paper employed a questionnaire survey to elicit the important criteria affecting in retrofitting of existing buildings in HLI with clean energy retrofit initiatives that encompasses of solar PV, wind turbines, and small-scale hydropower. Each of these initiatives has been established with the main criteria and sub-criteria to allow the respondents that consist of experts in green building design to provide the rate of importance by indicating the scale from 1-5. The establishment of criteria is based on the critical review collected through the secondary data. A total of 110 of the questionnaire were distributed, however, 54 of them has successfully respond which represents 21.26% of response rate.

Factor Analysis, Factor Score, and Weightage Factor were adopted as a method of analysis. These three types of analysis are interconnected with each other because Factor Score can be performed once the data has been reduced into a small set of numbers through Factor Analysis and the Weightage Factor output is produced based on the continuation of the Factor Score analysis because they are mutually dependent. These three types of analysis are finally assisted to produce the weightage output that can prioritize and ranked in the form of arrangement according to its importance.

5.1 Factor Analysis (FA)
FA is basically performed with IBM Statistical Package for Social Science (SPSS) 21. FA is a technique for data reduction by collapsing a large number of variables into several factors. It allows being generated in a manageable form prior to performing with other analysis [35]. FA involves several protocols, firstly, it is required to assess the Kaiser-Meyer-Olkin (KMO) to test the adequacy of sampling. KMO comes in a range from 0 to 1 and the acceptable minimum value is 0.50 [36]. Secondly, the statistical significance is tested through Barlett's Test of Sphericity with a significant value which is P<.05. Thirdly, the type of factor of extraction is chosen to allow it to produce the best and smallest number of factors. Then, the process continues with the factor rotation in order to interpret the number of variables to be a group of factor [35]. Lastly is the determination with the factor loading value whereby the minimum suggested value is 0.50 [37]. In this paper, the FA analysis
was performed with Principal Component Analysis with Varimax Rotation as a method of extraction and the factor of rotation with the factor loading 0.50.

5.2 Factor Score (FS)
Once a large number of variables has been reduced through the adaption of Factor Analysis, the findings obtained were further analysed with FS and WF. FS was normally conducted after performing the FA with the intention to use it for further analysis such as to identify the detail rankings or to determine the score between one another or in a group of category (Di Stefano, 2009). Therefore, FS allows further justification with the variables developed based on the numerical value assign. The method to calculate the FS is by multiplying the Factor Loading (FL) from each of the variables with the same Mean value (average Mean value), Y. The multiplying process will produce Factor Score for sub-criteria, FSsc [38].

5.3 Weightage Factor (WF)
The WF analysis is carried out to further analyse the result obtained from FS to produce its own weightage. According to [39], WF allows to make a comparison or to see the influence of the variables in the group. The steps taken to measure WF is firstly by adding up all the value of FSsc obtained from the FS earlier to produce the ΣFSc. Then, each of the FSsc is divided with the ΣFSc value. After the division method is carried out, all values should be added and the summation of result should equal to 1 with a percentage 100 %. A basic formula for WF as shown in equation (1) below:

\[
\pi_{\text{subcriteria}} = \frac{\% \text{ Stratum in Variables (sub-criteria), FSsc}}{\% \text{ Stratum in Criteria, FSc}}
\]

Where;
FSsc = Factor score for each item in the sub-criteria
ΣFSc = Cumulative of factor score in the criteria

6. Findings
6.1 Solar Photovoltaic
Table 2 shows the results derived from the FA, FS and WF Analysis for Solar PV. For FA analysis, there are 39 variables loaded subjected to Principal Component Analysis with Varimax rotation. From the rotation, 3 of the variables have been eliminated due to the factor loading is less than the minimum value of 0.50. The FA result that reached 0.50 and above are only presented in the table. For WF analysis which is performed after the FS analysis, each of the sub-criteria that is gathered into its own main criteria category has achieve its own weightage value which is arrange according to its significance.

Firstly, under management criteria, certification and rebates have been at the first rank with a weightage of 16.643%, followed by funds and investment with a weightage of 15.873%, land and space with 15.367%, whilst lastly is feed in tariff scheme with a weightage of 11.889%. Secondly, for economic criteria, the third highest ranking consists of maintenance costs with the weightage of 16.512% and it is followed by capital investment with a weightage of 16.108% and payback period with 15.745%. Thirdly, under the environmental criteria, visual impact is at the highest weightage with a value of 18.953%, followed by cultural landscape with a weightage of 17.474%, native vegetation and wildlife impact with a weightage of 17.179%, safety implication to fire hazard with 16.951% value, hazardous waste with 16.587% value and lastly is greenhouse gas emission with 12.856% value. Meanwhile, under PV features criteria, life expectancy of PV module has been indicated as the most significant by respondents with the weightage of 11.035%. Then, manufacturability achieved at the second highest rank with a weightage of 10.875%, followed by
mounting system with 10.539% value and PV system size with 10.525% value. Lastly, under the design criteria, the highest weightage is concerned with solar irradiation with the weightage value of 19.095%. Then, the second highest is achieved by site solar resource with the weightage of 18.679%, followed by orientation with 16.986% value, reliability with 16.264% value, time use and session with 14.488% value and lastly the ability to withstand structural and wind loading with 14.488% value.

Table 2. Results from Factor Analysis, Factor Score and Weightage Factor for Solar PV.

| Main Criteria   | Sub-Criteria                              | Factor Loading (FL) | Mean (X) | FSc | Weightage Factor |
|-----------------|-------------------------------------------|---------------------|----------|-----|------------------|
| Management      | Maintenance cost                          | 0.818               | 4.296    | 3.445 | 0.163            |
|                 | Initial capital investment                | 0.798               | 4.111    | 3.361 | 0.161            |
|                 | Payback period                            | 0.780               | 4.204    | 3.285 | 0.157            |
|                 | Construction cost                         | 0.770               | 4.278    | 3.243 | 0.155            |
|                 | Cost and energy saving                    | 0.718               | 4.241    | 3.024 | 0.145            |
|                 | Return on investment                      | 0.535               | 4.111    | 2.253 | 0.108            |
|                 | Purchase material                         | 0.535               | 4.241    | 2.253 | 0.108            |
| Economic        | Visual impact                             | 0.833               | 3.667    | 3.214 | 0.190            |
|                 | Cultural Landscape                        | 0.768               | 3.667    | 2.963 | 0.175            |
|                 | Native vegetation and wildlife impact     | 0.755               | 3.833    | 2.913 | 0.172            |
| Environmental   | Safety implication to fire hazard         | 0.745               | 4.130    | 2.874 | 0.170            |
|                 | Hazardous waste                           | 0.729               | 3.944    | 2.812 | 0.166            |
|                 | Greenhouse gas emission                   | 0.565               | 3.907    | 2.180 | 0.129            |
| PV Features     | Life expectancy PV module                 | 0.757               | 4.074    | 3.027 | 0.110            |
|                 | Manufacturability                         | 0.746               | 4.019    | 2.983 | 0.109            |
|                 | Mounting system                           | 0.723               | 3.796    | 2.891 | 0.105            |
|                 | PV system size                            | 0.722               | 4.204    | 2.887 | 0.105            |
|                 | Type of panel module                      | 0.698               | 4.056    | 2.791 | 0.102            |
|                 | Array frames type                         | 0.687               | 3.704    | 2.747 | 0.100            |
|                 | Warranty                                  | 0.678               | 4.000    | 2.711 | 0.099            |
|                 | Durability and longevity                  | 0.674               | 4.056    | 2.695 | 0.098            |
|                 | Grid-connected and stand-alone            | 0.621               | 3.907    | 2.483 | 0.091            |
|                 | Tilt/pith angle of PV array               | 0.554               | 4.167    | 2.215 | 0.081            |
| Design          | Solar Irradiation                         | 0.688               | 3.926    | 1.889 | 0.191            |
|                 | Site solar resource                       | 0.673               | 0.714    | 1.848 | 0.187            |
|                 | Orientation                               | 0.612               | 3.889    | 1.680 | 0.170            |
|                 | Reliability                               | 0.586               | 3.944    | 1.609 | 0.163            |
|                 | Ability of structure to withstand         | 0.522               | 4.000    | 1.433 | 0.145            |
|                 | the structural wind loading               | 0.522               | 4.074    | 1.433 | 0.145            |
|                 | Time use and session                      | 0.522               | 4.074    | 1.433 | 0.145            |
|                 | TOTAL                                     | 3.9983              | 27.428   | 1.000 | 100              |
|                 | TOTAL                                     | 3.858               | 16.956   | 1.000 | 100              |
|                 | TOTAL                                     | 2.7455              | 9.892    | 1.000 | 100              |
6.2 Wind Turbine

Table 3 presents the results derived from the FA, FS and WF for the retrofitting of existing buildings with Wind Turbines. For FA analysis, there are 40 variables loaded subjected to Principal Component Analysis with Varimax rotation. From 40 variables loaded under 5 main criteria, 3 of the variables have been eliminated as the factor loading is less than 0.50. The summary result of strong factor loadings for wind turbine is as tabulated in the table below.

For WF which performed after the FS has been conducted, each of the sub-criteria has produced its own weightage. Firstly, under economic assessment criteria, the highest weightage achieved is concerned with a payback period with a value 14.713%, followed by return on investment with factor loading 13.764%, whilst the least is investment costs with a weightage of 9.379%. Secondly, for wind resource criteria, the wind speed changes are indicated by respondents as the most significant with a weightage of 22.119%. The second highest weightage is to determine the annual mean wind speed with a weightage of 20.311%, and then followed by estimate the turbulence intensity, and lastly is wind generator capacity with a weightage of 18.475%.

Table 3. Results from Factor Analysis, Factor Score and Weightage Factor for Wind Turbine.

| Main Criteria            | Sub-Criteria                          | Factor Loading (FL) | Mean (X) | FSsc | Weightage Factor | %     |
|--------------------------|---------------------------------------|---------------------|----------|------|------------------|-------|
| Economic Assessment      | Payback period                        | 0.822               | 4.040    | 3.372| 0.147            | 14.713|
|                          | Return on Investment                  | 0.769               | 4.070    | 3.155| 0.138            | 13.764|
|                          | Annual and cost energy                | 0.759               | 4.100    | 3.114| 0.136            | 13.905|
|                          | Connection and foundations            | 0.721               | 4.130    | 2.958| 0.129            | 12.905|
|                          | Land rents, royalties                 | 0.687               | 3.950    | 2.818| 0.123            | 12.296|
|                          | Cost of wind turbines                 | 0.677               | 4.170    | 2.777| 0.121            | 12.117|
|                          | Repair and maintenance                | 0.628               | 4.190    | 2.576| 0.112            | 11.240|
|                          | Investment cost                       | 0.524               | 4.170    | 2.150| 0.094            | 9.379 |
|                          | **TOTAL**                             | **4.103**           | **22.921**| **1.000**| **100**         |       |
| Wind Resource            | Wind speed changes                    | 0.783               | 3.910    | 3.118| 0.221            | 22.119|
|                          | Mean wind power density               | 0.719               | 3.980    | 2.863| 0.203            | 20.311|
|                          | Annual mean wind speed                | 0.715               | 4.130    | 2.847| 0.202            | 20.198|
|                          | Turbulence intensity                  | 0.669               | 3.850    | 2.664| 0.189            | 18.898|
|                          | Wind generator capacity               | 0.654               | 4.040    | 2.604| 0.185            | 18.475|
|                          | **TOTAL**                             | **3.982**           | **14.096**| **1.000**| **100**         |       |
6.3 Small-Scale Hydropower

Table 4 presents the results derived from the FA, FS and WF for the retrofitting of existing buildings with small-scale hydropower. The FA has uploaded 28 variables subjected to the Principal Component Analysis. From the rotation, there is only 1 variable that was eliminated due to the factor loading is less than 0.50. The result of factor loading with a value 0.50 and above can be seen in Table 6.

Meanwhile, for WF which is performed based on the continuation of FS analysis, each of the sub-criteria has achieved its own weightage which also can be seen in Table 4. Firstly, the financial incentives, owners of the land, permit and approval process has achieved the weightage of 34.257%, 34.950% and 30.793% respectively under the management criteria. Besides, for the design criteria, proper design for civil works components is indicated as the most significant by respondents with a weightage of 14.943%, followed by transmission and distribution method with 15.100% value, power house component with 13.161% value, electronic load component with 12.887% value and drive system with 12.280% value. Under site assessment criteria, the highest factor loading ranked by respondents is to find the best geographical areas with a weightage of 19.230%, followed by indication for potential power and energy with a weightage of 18.197%, access for construction equipment with 17.695% value, a nearby demand with 17.129% value and lastly is the nearest electricity power lines with a weightage of 13.628%. Meanwhile, for cost and economic criteria, the respondents concerned towards the significant energy and cost saving which is at the highest rank with a weightage of 18.539%. Then, it is followed by payback period with a weightage of 17.482%, investment cost with 15.277% value, return on investment with 14.197% value, operating and maintenance cost with
18.585% value and construction cost with 15.920% value. Last but not least, under the environmental criteria, potential noise impact on nearby building is rated as the most significant with a weightage of 27.177%, followed by land use with a weightage of 26.323%, greenhouse gas emission with 25.367% value, and fisheries populated habitats with 21.133% value.

Table 4. Results from Factor Analysis, Factor Score and Weightage Factor for Small Scale Hydropower.

| Main Criteria          | Sub-Criteria                              | Factor Loading (FL) | Mean (X) | FSc      | Weightage |
|------------------------|-------------------------------------------|---------------------|----------|----------|-----------|
| Management             | Financial incentives                       | 0.791               | 4.20     | 3.222    | 0.343     | 34.257    |
|                        | Owners of the land                        | 0.807               | 3.96     | 3.287    | 0.350     | 34.950    |
|                        | Permits and approval process               | 0.711               | 4.06     | 2.896    | 0.308     | 30.793    |
|                        |                                           | 4.073               | 9.405    | 1.000    | 100       |
|                        | Properly design for civil works components| 0.763               | 4.13     | 3.132    | 0.149     | 14.943    |
|                        | The transmission and distribution network  | 0.771               | 4.20     | 3.165    | 0.151     | 15.100    |
|                        | Power house component                      | 0.672               | 4.22     | 2.759    | 0.132     | 13.161    |
|                        | Electronic Load Component                 | 0.658               | 4.09     | 2.701    | 0.129     | 12.887    |
|                        | Drive system                              | 0.627               | 4.06     | 2.574    | 0.123     | 12.280    |
|                        | Choosing a system                         | 0.556               | 4.07     | 2.282    | 0.109     | 10.889    |
|                        | Sizing of the system                      | 0.554               | 4.09     | 2.274    | 0.108     | 10.850    |
|                        | Length of diversion                       | 0.505               | 3.98     | 2.073    | 0.099     | 9.890     |
|                        |                                           | 4.105               | 20.960   | 1.000    | 100       |
|                        | Find the best geographical areas          | 0.714               | 4.30     | 2.926    | 0.192     | 19.230    |
| Site Assessment        | Indication for potential power and energy  | 0.675               | 3.98     | 2.766    | 0.182     | 18.179    |
|                        | Access for construction equipment          | 0.657               | 4.13     | 2.693    | 0.177     | 17.695    |
|                        | Power required                            | 0.525               | 4.17     | 2.152    | 0.141     | 14.140    |
|                        | A nearby demand for electricity           | 0.636               | 4.07     | 2.607    | 0.171     | 17.129    |
|                        | Nearest electricity power lines           | 0.506               | 3.94     | 2.074    | 0.136     | 13.628    |
|                        |                                           | 4.098               | 15.217   | 1.000    | 100       |
| Economic               | Significant energy and cost saving        | 0.807               | 4.09     | 3.348    | 0.185     | 18.539    |
|                        | Payback Period                            | 0.761               | 4.06     | 3.157    | 0.175     | 17.482    |
|                        | Investment cost                           | 0.665               | 4.02     | 2.759    | 0.153     | 15.277    |
|                        | Return on Investment                      | 0.618               | 4.17     | 2.564    | 0.142     | 14.197    |
|                        | Operating and maintenance                 | 0.809               | 4.33     | 3.356    | 0.186     | 18.585    |
|                        | Construction cost                         | 0.693               | 4.22     | 2.875    | 0.159     | 15.920    |
|                        |                                           | 4.148               | 18.058   | 1.000    | 100       |
| Environmental          | Noise impact on nearby building           | 0.796               | 3.98     | 3.280    | 0.272     | 27.177    |
|                        | Land use                                  | 0.771               | 4.02     | 3.177    | 0.263     | 26.323    |
|                        | Greenhouse gas emission                   | 0.743               | 4.37     | 3.061    | 0.254     | 25.367    |
|                        | Fisheries populated habitats              | 0.619               | 4.11     | 2.550    | 0.211     | 21.133    |
|                        |                                           | 4.120               | 12.067   | 1.000    | 100       |
7. Conclusion
Clean energy is the main key driver that is beneficial not only for the nation, but also for the future in this globe. Since most of the power generation comes from the sources of fossil fuels, there has been an increase in concern with the global warming, and thus renewable energy has increasingly become an important source to generate energy. Considering the clean energy as part of the decision to retrofit existing buildings could become one of the great solutions to achieve for sustainable development and to become zero energy building. A building campus is one of the potential opportunity for retrofitting implementation and could serve as a pioneer in promoting as well as transforming the existing electricity generation through utilization of renewable energy. Basically, the implementation of retrofitting involves with the decision-making process in order to identify the alternatives or preferences. Therefore, the development of the clean energy criteria in this paper is hoping that it will be able to serve the stakeholders who is involved with the required information throughout the decision-making process. The findings from the weightage is also to provide a reference which criteria that is important to consider when implementing the clean energy initiatives.

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