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Electronic Energy Benchmarking System (e-EBS) towards Sustainable Building Energy Performance

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Abstract

Taking into account the global scenario on energy use in, and the resultant carbon emission from buildings, there is a need to take an integrated approach to manage building carbon footprint by consolidating a comprehensive green building rating scheme and efficient building energy management and reporting tool into a robust benchmarking. However, currently there is no centralized system for energy performance that is integrated with green rating tool for government buildings in Malaysia. The aim of this paper is to explore the potential of an electronic energy benchmarking system (e-EBS) that integrates the assessment scoring of the Penarafan Hijau Jabatan Kerja Raya (pHJKR) rating scheme with the Jabatan Kerja Raya Energy Online System (JENOSYS) to give a more comprehensive energy performance benchmarking for a building. The pHJKR is a green building rating scheme that was created to assess the sustainable performance of buildings while considering the most recent legislative requirements. The system in this study consists of three (3) modules that automatically analyses data acquired from a user building and ultimately processes the final report, in accordance with pHJKR requirement. The e-EBS conceptual module and process flow were highlighted. The study also proposed the requirement specification for the e-EBS. The future work is the validation of the module using government offices, university faculties, and mosques as case studies to evaluate the interfacing of the modules. Prior to the validation process, energy audit reports of the case study buildings will be compared and analyzed to indicate which case study building comes with the best energy benchmark according to the Malaysian Standards (MS) 1525:2019 and pHJKR.

Keywords: Energy benchmarking system, green buildings in Malaysia, green rating, sustainable energy management, system integration

1.0 INTRODUCTION

The United Nations Environment Programme (UNEP), together with the International Energy Agency (IEA) has released the 2020 Global Status Report for Buildings and Construction (UNEP, 2020), in which it stated that the CO_2 emissions from the building rose to 10 Giga tonne equivalent CO_2 ($GtCO_2$) in 2019, the highest level ever recorded, or 28% of total global energy-related CO_2 emissions. Electricity consumption in building operations represents nearly 55% of global electricity consumption. Buildings account for up to 40% of total global energy use. By 2030, consumption is predicted to rise to 50% of current rates (Hassan et al., 2014; Pandey, 2016). Buildings in Malaysia absorb 50% of the country's total power generation.

The way forward to reduce carbon emission from building operations can be found in the strategies laid out in the National Green Technology Action Plan 2017-2030, whereby the target for reduction of carbon for government buildings from 10.9 kilotonne equivalent CO_2 ($ktCO_2eq$) in 2014 to 98.2 $ktCO_2eq$ in 2020. In addition to the target, energy audit and energy management in buildings, as well as energy efficient building design, are the initiatives recommended in the National Energy Efficiency Action Plan 2021-2025 (Ministry of Energy, Green Technology and Water, 2015). As part of the effort to support the action plan, Jabatan Kerja Raya (JKR) has developed the Jabatan Kerja Raya Energy Online System (JENOSYS) with the aim to monitor the energy performance in government buildings, partly in order to achieve 8% national energy saving by 2025 (Wajid et al., 2018).

In order to evaluate and rate the energy performance of buildings in Malaysia, the Malaysia Green Building Index (GBI) rating tool was established in January 2009 by the Architectural Association of Malaysia (PAM) and Association of Consulting Engineers Malaysia (ACEM) (GSB, 2009). The GBI framework was developed to take into account the Malaysian climate. It is a comprehensive rating system and environmental evaluation that is used to assess the environmental design and performance of Malaysia's structures and it focuses on six (6) main categories, namely Energy Efficiency (EE), Materials and Resources (MR), Water Efficiency (WE), Indoor Environmental Quality (IEQ), Sustainable Site Planning and Management (SM) and Innovation (IN) (Pandey, 2016; Tan, 2009). The GBI allows

developers and building owners to design and construct green, sustainable buildings that can save energy, water, and still provide a healthier indoor environment, reducing our environmental impact.

On the public sector side, Penarafan Hijau Jabatan Kerja Raya (pHJKR) green rating tool was developed by the Public Works Department Malaysia, or Jabatan Kerja Raya Malaysia (JKR) based on the performance of existing buildings in terms of sustainability while recognizing the most recent regulatory requirements. Since the 8th Malaysian Plan, JKR has been implementing green initiatives in its projects (CIDB, 2018). JKR developed and implemented pHJKR to assess the level of sustainability of its construction projects. The design stage is the emphasis of pHJKR, and the evaluation is based on a set of criteria. It applies to four types of buildings, namely non-residential new building, non-residential existing building, non-residential without air conditioner, and the health facility building.

Taking into account the global scenario on energy use in, and the resultant carbon emission from buildings, there is a need to take an integrated approach to managing building carbon footprint by consolidating a comprehensive green building rating scheme and efficient building energy management and reporting tool into a robust benchmarking. In addition to that, the research attempts to bridge the gap between energy monitoring systems with the green building rating tools in Malaysia. This is because there are few online monitoring systems developed by the companies or government departments in Malaysia. As a result, the energy monitoring system operates independently of the green building certification process. Consequently, this imposes a challenge to building owners who have to use several separate tools to do benchmarking. The aim of this paper is to explore the potential of an electronic benchmarking system that integrates the assessment scoring of the pHJKR rating scheme with the JENOSYS to give a more comprehensive energy performance benchmarking for a building.

2.0 RELATED WORKS

Green building index is the local grading system to assess building environmental design and performance. It is continually used to evaluate for further development of a building environment comfort post building assessment and validation as a green rated building.

A field study on Indoor Environmental Quality (IEQ) was done on GBI-rated office buildings located in Kuala Lumpur or Putrajaya, Malaysia (Tharim et al., 2018). The field investigation was conducted on two gold-rated and two platinum-rated government office buildings, where one building from each category is located in Kuala Lumpur and Putrajaya. The purpose of the investigation was to evaluate the indoor thermal comfort in buildings that adopt green façade-shading devices post-occupancy period with the provision of GBI guidelines by analyzing the responding variables- indoor air temperature, indoor relative humidity, mean radiant temperature, and indoor air velocity. The variables were measured and recorded after the manipulation of various façade-shading devices for thermal performance. The spaces selected in the four office buildings were where normal administrative work commenced, involving everyday office tasks and all air-conditioners and lightings were in normal daily operation during the measurement processes. The results were analyzed then compared with GBI guidelines as results indicator. The results in the study confirmed that the thermal comfort performance of each building was acceptable within the parameters of the GBI tool for IEQ and the indoor conditions in these buildings suffice as benchmarks for green office buildings in Malaysia and South-East Asia.

Similar fieldwork assessing on IEQ was done, but only on full or semi-government buildings located in Kuala Lumpur or Putrajaya with the highest GBI rating were considered. The chosen buildings were awarded Platinum Final Certification by GBI Malaysia and Green Mark Singapore. Four office buildings in the criteria were selected as the research case study; however, the paper only focused on a building in Putrajaya (Tharim et al., 2017). Data collection in the selected building was conducted from 9.30 a.m. until 4.30 p.m., on five working days between 4 and 10 May 2016, during one of Malaysia's driest months (Malaysian Meteorological Department). The responding variables analyzed were indoor air temperature in response to the outdoor temperature, heat transfer and solar radiation, thermal comfort affected by the relative humidity and air velocity in the building, indoor air quality affected by the concentration of CO_2, as well as visual lighting and background noise. The results were compared to the GBI under the Non-Residential New Construction (NRNC) tools category. The selected building has passed to be re-certified after five (5) years of operation because the building's IEQ meets the GBI standards of a green office building. The results provided are useful as a valuable benchmark for green office building developments in the aspect of IEQ.

The process for GBI assessment and certification is carried out manually (Khoshdelnezamiha et al., 2020). Research and development on automating the GBI course was done as a supplementary application to the existing Building Information Modelling (BIM) authoring software, Revit. However, the BIM existing tools on sustainability assessment guidelines are not entirely in accordance with GBI requirements with regards to local references, baselines, and method of calculation, analysis, and documentation. The research approaching mechanism is by addressing GBI local standards for green building designs when designing a BIM template, enabling automated assessment of green rate extraction from a BIM model and production on documentation. The application was validated by applying it on a sample BIM model. Two analyses were done, where one sample BIM model was processed as an input via the automated application, and another model of similar building via the conventional method. As a demonstration, the Overall Thermal Transfer Value (OTTV) was assessed from the GBI Energy Efficiency subcategory. The application report contains a summary of building data retrieved from the sample BIM model, such as façade area, orientation, heat transfer coefficients, and shading coefficients. The calculation carried out by the designed tool was verified by manually calculating the OTTV of similar model using the Building Energy Information Tool (BEIT). The calculation showed a differential error of 3.57% between BEIT and the designed Automated Green Building Assessment tool (AGBIA) due to limitations in parametric inputs from the conventional method. Additionally, visual programming was incorporated in the study to automate the process of creating Revit green project template from a BIM model with respect to GBI guidelines. The output of the study is a set of standard property sets in the green project template and a report pertaining to provisional GBI rating that can be used as supporting documents for GBI assessment. By incorporating GBI guidelines, designers may maximize their use of the BIM authoring tool and automate the assessment and documentation of green buildings.

An extensive study by the School of Civil Engineering, Mara University of Technology (UiTM) was conducted with the aim to investigate the behaviors and practices of industry in the green practices of building industries (Mustaffa et al., 2021). The method of the study provided triangulation of information by using a mixed method of six case studies for green and conventional buildings, fifty-four (54) respondents from the selected stakeholders to a cross-sectional survey questionnaire and interviews on seven industry experts. The building categories were office buildings, hospitals, and shopping malls located in Klang Valley, Malaysia. The exact locations and names of the buildings were kept private at the request of the building management. Each category presents two buildings, one rated as green building and another as conventional building. These buildings were examined on the extent of the operational carbon and cost performances in both green and conventional buildings for different categories. Energy consumption and cost implication data for all six buildings were analyzed. The cumulative energy usage for all the buildings' operations was measured for a year of electricity usage in terms of kWh. Additionally, the cumulative data were converted to carbon equivalent by referring to the United Kingdom (UK) DEFRA carbon emission conversion factor (Defra & DECC, 2012) – (Annex 10-International Electricity Emission Factors) to convert from direct/ indirect energy consumption to carbon equivalent. The operational energy cost data were available in the Malaysian Ringgit currency (MYR). The analyzed data showed that the differences in electricity usage between these buildings are due to different operating hours and plug loads. The data outcome confirmed an earlier study that said a green building potentially reduces energy usage by an average of 33%.

From the building energy management context, a study was conducted on the energy performance of twenty-three (23) buildings under Jabatan Kerja Raya (JKR) to evaluate the applicability of Jabatan Kerja Raya Energy Online System (JENOSYS), where the criteria of these buildings were categorized as normal building and workshop building. The analysis was taken based on the Single Energy Use (SEU) of each building because of the difficulty in accumulating the data on SEU for each system. This is for the sake of consistency because these buildings have two types of billing method, where several buildings share a bulk of energy meter, and the other have individual meter for each building. The process flow of the JENOSYS starts with a preliminary study of energy consumption, where the electricity bill of a user building is acquired from the Tenaga Nasional Berhad MyTNB portal then fed into the database of the JENOSYS. The overall consumption is extracted and analyzed to display the monthly energy consumptions, Building Energy Intensity (BEI), and the monthly and cumulative energy savings in terms of kilowatt-hour (kWh), percentage values as well as the utility cost in Malaysian Ringgit currency (MYR).

The previous research presented extensive methods and results regarding the energy profile of office buildings, hospitals, and shopping malls. Although the aims are different, the preliminary data acquisition of energy consumption of case buildings is as crucial. However, these studies have not covered the mechanism and medium required for the preliminary study of the energy consumption of the stipulated buildings. There is no mention in the previous studies on extraction of energy performance data from, or logging into, an energy benchmarking system.

Apart from the discussed related works, there is a research gap on the feasibility of coupling an online building energy management and reporting tool with a green building rating scheme in Malaysia. The aim of this study, therefore, is to integrate the assessment scoring of the pHJKR rating scheme with JENOSYS to create an energy benchmarking system for a building. The result from this study will contribute to the body of knowledge on the development of electronic energy benchmarking system towards sustainable energy management for buildings in Malaysia.

3.0 METHODOLOGY

The proposed e-EBS consists of three modules; Module 1, where Jabatan Kerja Raya Energy Online System (JENOSYS) operates as the baseline module, Module 2 where the energy saving measures are accessed from the energy audit report, and Module 3 is the Penarafan Hijau Jabatan Kerja Raya (pHJKR) green rating scheme. The sub-modules, process flow, and the outcome of the modules are shown in Figure 1.

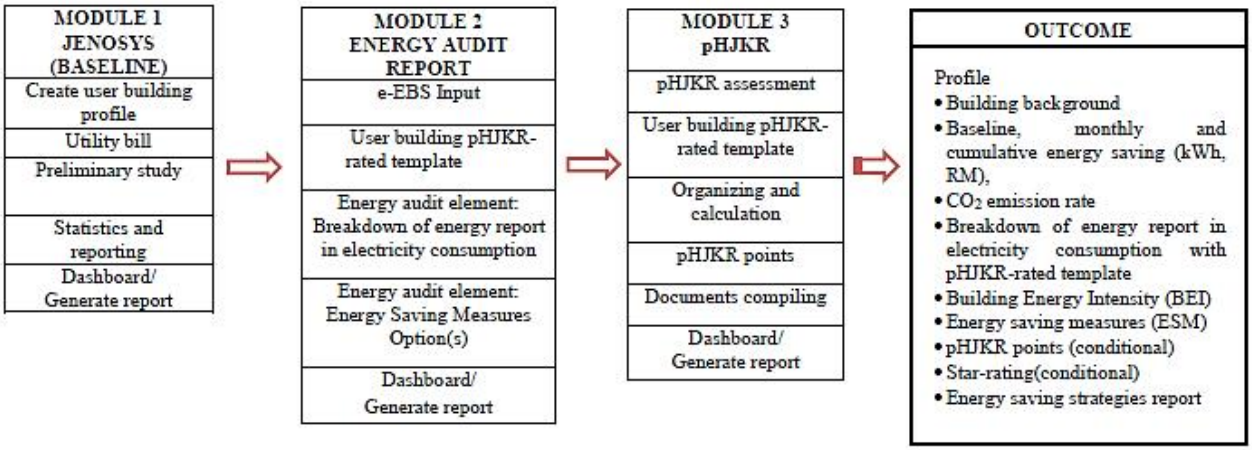

Figure 1 e-EBS module design

Module 1 contains the preliminary study of energy performance data of a user building is acquired from JENOSYS. The preliminary study focuses on the energy performance in terms of energy savings in kilo-watt hour (kWh), and utility cost (Malaysian Ringgit currency, MYR). The quantitative data will be acquired from the utility bill and manually logged into the system by a designated building officer. The system then automatically calculates the energy baseline. Further, the analyzed numeric data will be summarized as charts displaying the monthly and cumulative energy consumption against the baseline and savings in energy consumption in terms of (kWh), (MYR), and percentage values (%). Additionally, the numeric data will also contain the carbon emission rate for the electricity consumption that will be calculated against the baseline of carbon emission.

Module 2 is proposed such that to identify Building Energy Indices with a pHJKR-rated template. Module 2 is of energy audit elements associated with green parameters of pHJKR in e-EBS database, where the quantitative data such as temperature, pressure, flow, visual lighting, humidity, and solar radiation as well as concentration of CO_2 - from an energy audit digitally logged in the system to be summarized with the numeric data in Module 1. The summarized data can be further extracted and analyzed to recommend Energy Saving Measures (ESM) for the user building.

User building of the system has the option to continue with pHJKR conditional points in Module 3. The numeric data in the pHJKR-rated template will undergo defined calculation and be allocated with pHJKR points. The final output of the system is a user energy profile coupled with provisional pHJKR points which can be generated as a final assessment report. Each module discussed may generate independent reports of specified features. Moreover, each module allows distinct functional administration with respect to executive level (i.e., in module 1 only one officer gains access in managing data collection from bill utility per user building).

4.0 RESEARCH METHODOLOGY

This study uses a specific qualitative research approach, the focus group method and reports documented from experts' opinions in the main components to develop the proposed Electronic Energy Benchmarking System (e-EBS).

4.1 Participants and Planning Focus Group Workshop

The study is in the collaboration of University of Malaya (UM), and Jabatan Kerja Raya(JKR) with funding from the government type of grant from Centre of Excellence for Engineering and Technology (CREaTE). Thus, the focus group is built up of the above-mentioned three (3) organizations - University of Malaya, Jabatan Kerja Raya (JKR) and Centre of Excellence for Engineering and Technology (CREaTE). The focus group participants consist of experts, researchers, and a research assistant. The participants from the three (3) organizations did not know the other organization participants beforehand. However, the participants in the study were not anonymous as this is a collaborative study. The collaborative study is still on-going. As of the proposed Electronic Energy Benchmarking System Requirement Specification introduction, a total of two (2) designed focus group workshops have been conducted. Each focus group workshop was semi-structured with designed topics to discuss and highlight on.

4.2 Focus Group Workshops

Each focus group workshop conducted were semi-structured with research questions relevant in all stages of the study (Kontio et al., 2004). Table 1 shows the conducted workshops summarized with the outcome respectively.

Table 1 Semi-structured workshops

Focus Group	Duration	Participants	Topic	Outcome
Workshop 1	2 hours; 3 parts	UM, JKR, and CREaTE	Informational phase: Module Development for Electronic Energy Benchmarking System (e-EBS)	Conceptual Framework
Workshop 2	2 ½ hour; 3 parts	UM, JKR, and CREaTE	Propositional phase: User requirement study	System Requirement Specification

5.0 REQUIREMENT SPECIFICATION

As highlighted earlier, the system will be an integration of Jabatan Kerja Raya Energy Online System (JENOSYS) and the assessment scoring of the Penarafan Hijau Jabatan Kerja Raya (pHJKR) rating scheme to create an energy benchmarking system. e-EBS development process begin with identifying assessment subcategories and rating scheme of the pHJKR. In order to optimize the existing methods, the e-EBS operation is proposed to integrate the process of pHJKR in the database of the system.

The e-EBS requirement specification was resulted from studies conducted by the focus group of experts. The focus group studies begin with introducing the background and features of JENOSYS. Then, the focus group was introduced to pHJKR assessment guidelines. The pHJKR rating scheme evaluates based on a set of criteria. The criteria fall under seven (7) categories, Sustainable Site Planning and Management, Resource and Materials Management, Water Efficiency Management, Indoor Environment Quality Management,

Sustainable Facilities Management, Innovation and Design, and Energy Efficiency Management and Use of Renewable Energy. Other than that, the process flow of pHJKR involves four (4) main stages.

The first stage is the registration and application with validation period of two (2) years. The design evaluation process of a user building needs to be implemented within that period. In the second stage, conditional certificate will be issued based on joint evaluation of the project team. A random check on self-assessment will be done prior to the issuance of the conditional rating certificate. In stage three (3) is the verification of result where the rating certificates issued in the stage by a secretariat are three (3)-star rating and below. For four (4)-star rating and above, a user building must go through the validation process at stage four (4). The flowchart of each stage is attached in Appendix A, B, C, and D respectively.

This section proposes the requirement specification for overall e-EBS operation, as shown in Figure 2. The e-EBS development begins with data acquisition of a user building. Subsequently, a set of parameters critical in energy audit reports is designed to be further filled in with values. Afterward, the data collected is processed through defined calculation. The processed information will be further evaluated based on pHJKR assessment guidelines. The user building may opt to generate an energy saving strategies report in addition to the evaluation report for pHJKR certification supporting documents after earning provisional pHJKR points.

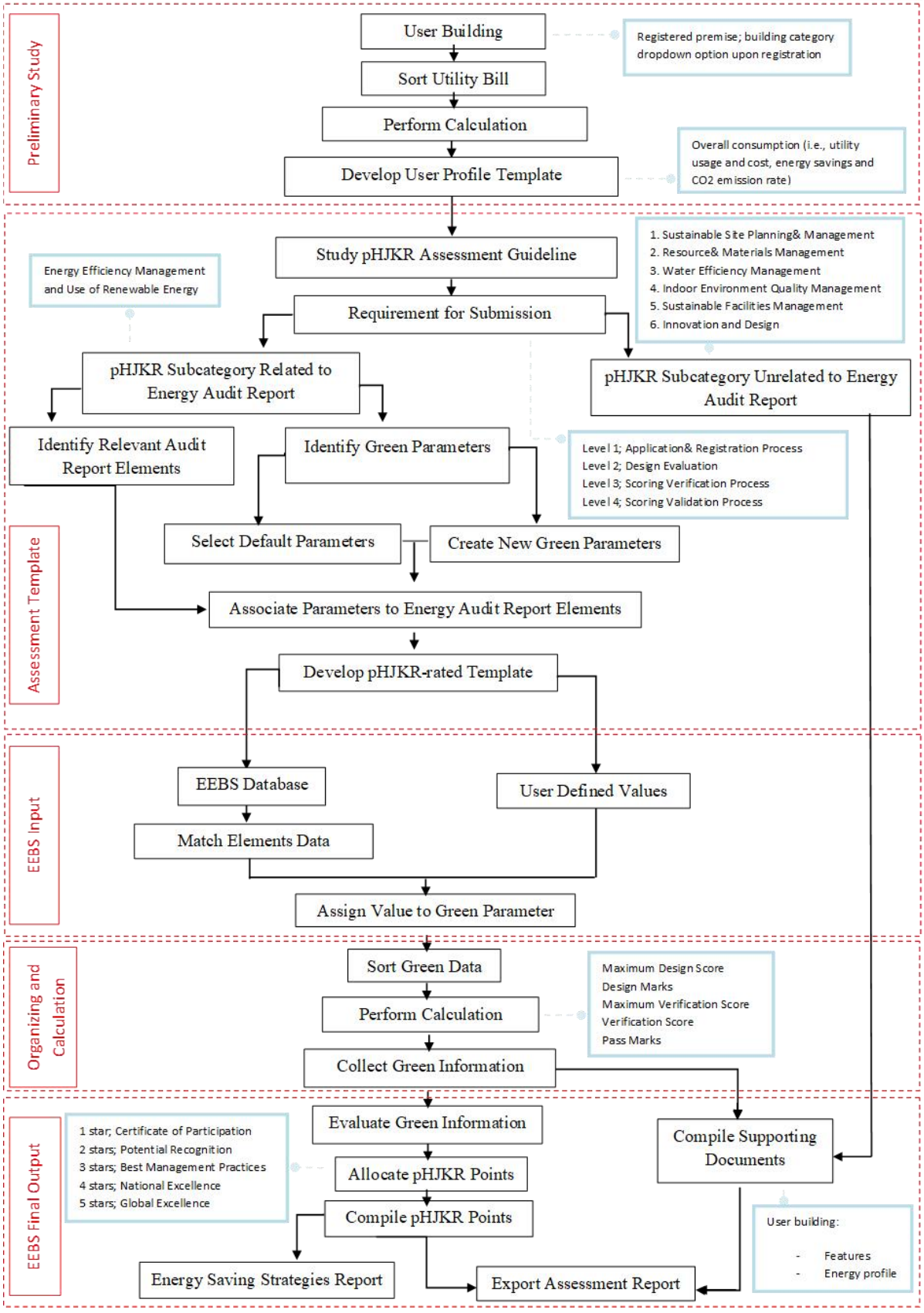

Figure 2 Energy benchmarking requirement specification

6.0 RESEARCH FINDINGS

The system is a holistic system providing the platform to practice sustainable energy management. The platform comprises a set of modules that require each other from one flow to another. The modules enable a synchronized preliminary study of energy profile catered for government buildings in Malaysia and enable the feature to zoom-in in the collected data to pinpoint the factor of electricity usage pattern. The e-EBS conceptual framework and energy benchmarking requirement specification were validated by the focus group of experts and will be used as guidelines for the physical development of e-EBS.

As mentioned, the workshops conducted were semi-structured with dedicated topics. A study to reflect on cases where the focus group method was implemented summarized that the focus group method is a low-cost method to capture qualitative feedback and understanding from practitioners. The focus group method can be used in different stages and patterns of research (Kontio et al., 2004).

Each focus group workshop conducted has divided parts to have dedicated topic relating to the workshop agenda. Each workshop started with giving an overview of the objectives and a discussion on the workshop topics in order to ensure that the participants' opinions represent the current situation and research stage. In addition to that, each workshop has materials readied by the participants to focus and emphasize on such as, the Jabatan Kerja Raya Energy Online System (JENOSYS) modules and features (Wajid et al., 2018) that have been partly adapted into the Conceptual Framework discussed as well as the assessment guidelines of Penarafan Hijau Jabatan Kerja Raya (pHJKR) scorecard based on subcategories and process flow main stages following the pHJKR-rated template.

6.1 Focus Group Design

The Electronic Energy Benchmarking System (e-EBS) development towards sustainable building energy performance started by getting the experts' opinions on the Jabatan Kerja Raya Energy Online System (JENOSYS) and assessment guidelines of Penarafan Hijau Jabatan Kerja Raya (pHJKR) rating scheme. The experts from University of Malaya (UM), Jabatan Kerja Raya (JKR), and Centre of Excellence for Engineering and Technology (CREaTE) participants shared his and her experiences and views toward the current practices of usage on energy management and green rating tools in Malaysia.

The experts' opinions lead to the focus group workshops conducted to assess the research questions in the informational and propositional stages of this study. The fist focus group workshop conducted aimed at to collect specific information about the background and features of the JENOSYS, and the assessment guidelines of pHJKR rating scheme.

In the second focus group workshop, the initial constructs i.e., the proposed Electronic Energy Benchmarking System (e-EBS) Requirement Specification resulted from the early opinions and feedback on the user requirement study of the e-EBS modules design, whereby the e-EBS modules design presents the process, users, stages, and modules involved in the development of the proposed e-EBS.

6.2 Focus Group Workshops Execution

The workshops conducted were audio and video recorded to capture and document all matters raised in the discussion during the workshops in addition to the materials prepared by the participants designed for the workshops respectively. The research assistant in the selected focus group participants of this study was assigned to take notes and taking part in the discussions based on her previous prioritization experiences. However, the research assistant's comments were not later analyzed and worked as an initiator to the participants.

The documents and commented materials from the workshops conducted were later analyzed and added into the monthly and quarterly progress reports to all three (3) participating organizations' management bodies. In addition to that, the documents enabled the following workshop to take-up on materials and matters intended to be highlighted with the research assistant's notes as initiator. This allowed the workshop agendas and discussions focused and semi-structured.

Moreover, the experts selected as participants in the focus group workshops range from the lead engineers, engineers, senior director, professors, associate professors, and researchers that have worked closely especially in the development of the Jabatan Kerja Raya Energy Online System (JENOSYS), identifying potential roots of Penarafan Hijau Jabatan Kerja Raya (pHJKR). Thus, the selected participants are able to confirm on the validity of the discussed Conceptual Framework and System Requirement Specification of the proposed e-EBS.

As the effort for this study discussed, the actual workshops only constitute a small share of total stages of the study. Yet these workshops provided data and are perceived as value adding workshops to participants and the development of this study continues as the planned physical progress schedule. The focus group workshops will continue to be conducted, when possible, to assess on the next development stages of e-EBS towards sustainable building energy performance.

6.3 Research Analysis

Preliminary study from Module 1 allows users to monitor and make comparison on the uniqueness of a user building profile. This is due to various tariffs are applied in various building areas. A user building profile may have multiple buildings in the same perimeter to allow the user to manage different categories of buildings (i.e., administrative buildings, maintenance workshop building) and the varying frequency of operations of the buildings.

Energy audit exercise is a method to evaluate the total energy consumption by a building and to identify potential energy saving measures. In Module 2, users can generate the BEI and have a breakdown of electricity usage to pinpoint the contributing load. Parameters critical in energy audit reports are associated with the green parameters from Penarafan Hijau Jabatan Kerja Raya (pHJKR) assessment. The acquired energy audit data are filled in in a formatted template in accordance with the standard and guidelines of pHJKR. This gives users a sustainable canvas to identify present and historical energy usage pattern.

The e-EBS consists of three modules that automatically analyze energy profile of a user building in accordance with pHJKR requirements. The integration of pHJKR in the system provides a more efficient method compared to the conventional and manual approach in assessment and documentation manually. This is said possible because upon investigating the pHJKR assessment guideline and submission requirements, a set of standard property sets will be identified as a pHJKR-rated template which will then be included into the e-EBS database. Subsequently, users would be able to extract, interpret, and process data in accordance with pHJKR guidelines. The final output from the system is a report on conditional pHJKR points and recommended energy saving strategies for further pHJKR certification assessment. Thus, the system takes a holistic approach for digital integration of various green building attributes. The next phase is the validation of the module using government offices, university faculties, and mosques as case studies to evaluate the interfacing of the modules. Prior to the validation process, energy audit reports of the case study buildings have been compared and analyzed together to publish a comprehensive report. The objectives from the energy audit are to provide indicator of the energy performance as well as to identify load apportioning, which then ESM are proposed according to the results. To achieve these objectives, energy consumption is analyzed together with factors like working days, and environmental aspects following the building façade. The data collected will come down to load apportioning and further breakdown of energy usage for the building. The actual energy consumption data are also compared with energy simulation and the BEI are compared with the Malaysian Standards (MS) 1525:2019 and pHJKR. ESM are proposed in each case study buildings that are categorized from no/ low cost, medium cost, and high cost.

7.0 CONCLUSION

The global scenario of increasing energy use in buildings which leads to increase in carbon emission has given an impetus to explore a more consolidating approach to managing building energy performance. The literature survey conducted suggests that the Malaysian GBI rating tool is continuously used in post-occupancy period, and the certification borne to a green rated building is validated with GBI standards. In this paper, an electronic energy benchmarking system was proposed. Its module design and requirement specification were discussed. The proposed electronic energy benchmarking system with integration of Penarafan Hijau Jabatan Kerja Raya (pHJKR) green rating scheme and the Jabatan Kerja Raya Energy Online System (JENOSYS) provides the building owners a comprehensive decision making tool to manage the energy performance, and ultimately the carbon footprint, of their buildings. It is recommended the research produce a study on energy audit report integrated with pHJKR guidelines that was conducted manually on case study buildings. This is so, the report can be used to verify the report generated from the proposed e-EBS in this research. Additional study on the full development of e-EBS could be produced in the final phase of the development where the physical system is developed using the conceptual framework and energy benchmarking requirement specification as guidelines.

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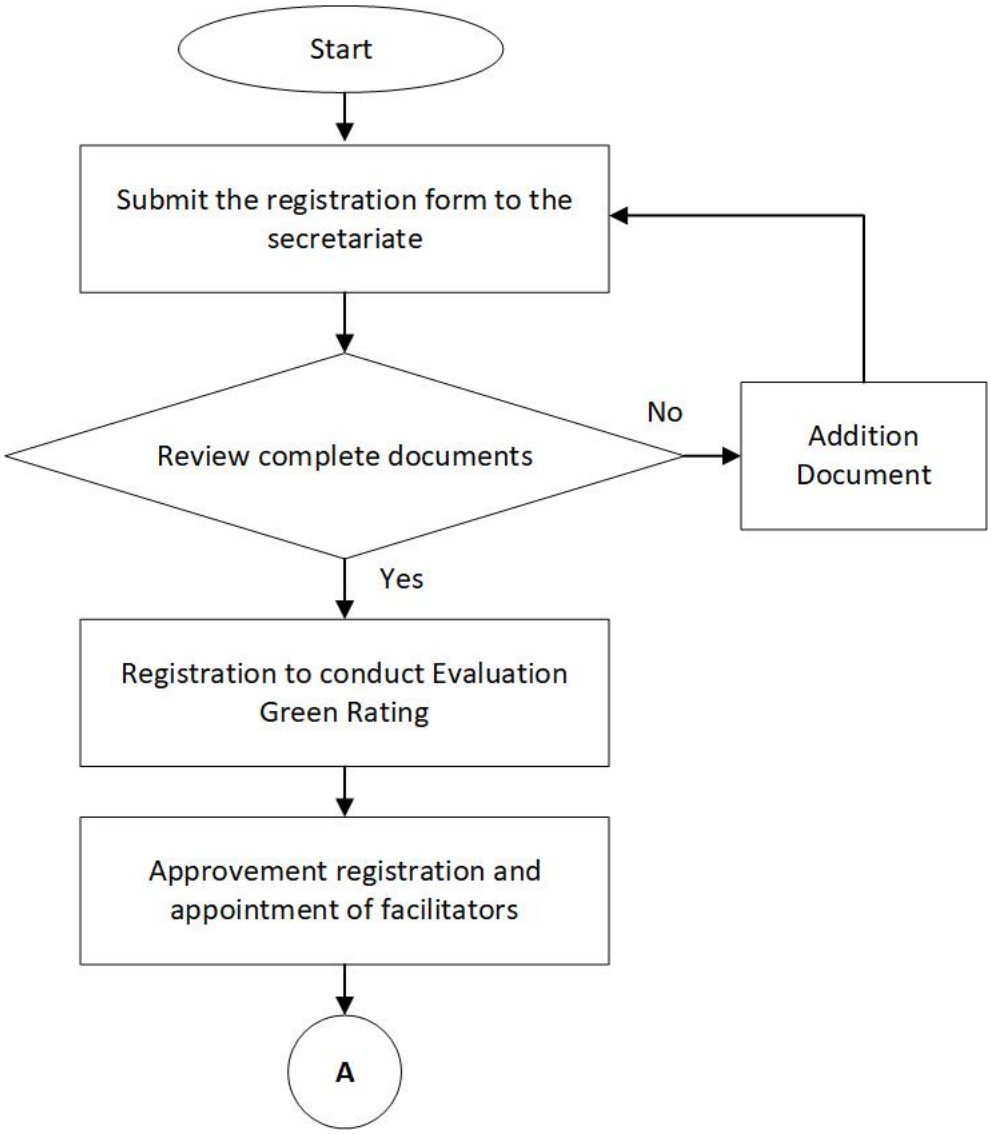
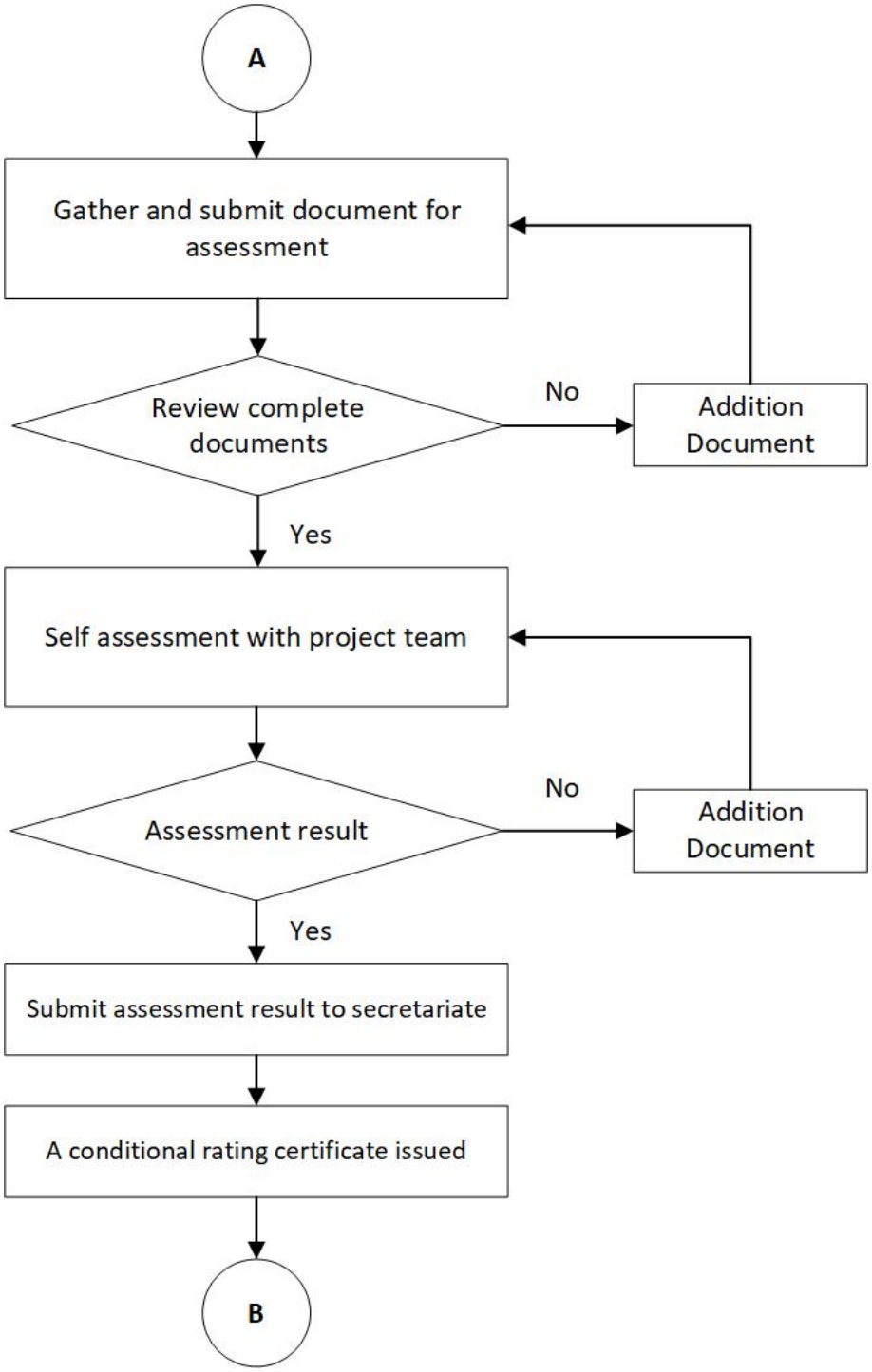
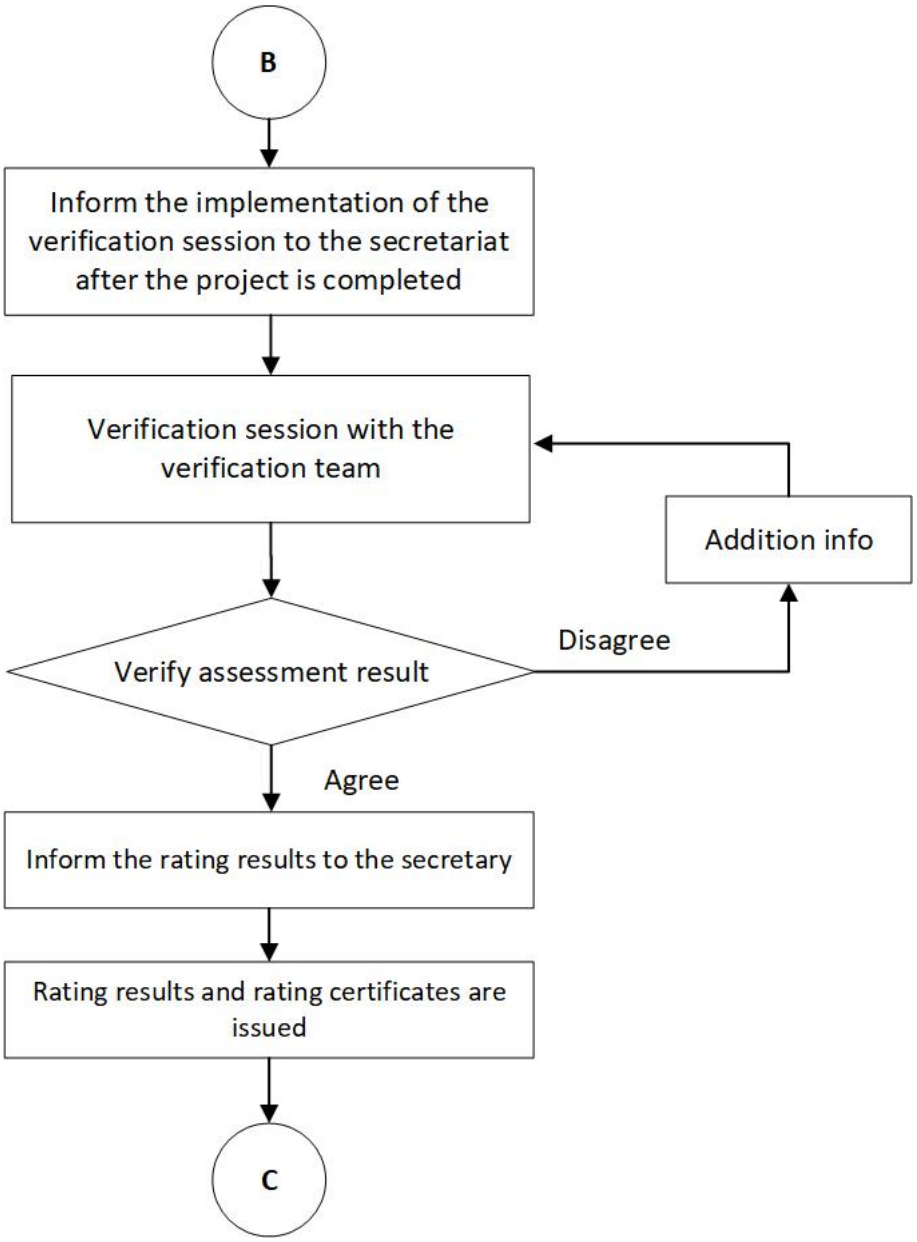
APPENDIX A
Process of pHJKR: Stage One (1) - Registration and Application



APPENDIX B
Process of pHJKR: Stage Two (2) - Design Evaluation



APPENDIX C
Process of pHJKR: Stage Three (3) - Score Verification



APPENDIX D
Process of pHJKR: Stage Four (4) - Score Validation