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Developing Visual/Protocol 1 Sustainable Condition Assessment (BSusCA) Tool for Non-Residential Existing Building

Syahrul Nizam Kamaruzzaman*, Nurshazreen Amirudin

Department of Building Surveying, Faculty of Built Environment, Universiti Malaya, Kuala Lumpur, Malaysia

*Corresponding author's email: syahrulnizam@um.edu.my

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Abstract

Global warming and the destruction of the environment are presumed to be the most serious environmental problems. In Malaysia, a lot of people have responded to green building assessment tools, which has led to a growth in green building construction. Sustainable development assessment towards building is an approach that can fulfil demands without neglecting future requirements. Presently, "Non-Destructive Inspections" is a protocol 2 assessment that directly measures sustainable building standards. However, it is unclear how a key idea of sustainable construction has proven its value in the assessment framework since it does not use any prelims in rating a sustainable building. Truthfully, prelims help building stakeholders make precise decisions and plan for the future based on the current state of the building. Otherwise, stakeholders may confront a variety of challenges such as unplanned incidents, the difficulty of the qualifying process, and urgent priority work, particularly if they are unfamiliar with the certification framework. The aim of this research is to overcome the gap of sustainable development assessment protocol 2 by developing a Visual/Protocol 1 Inspection Method for the Building Sustainable Condition Assessment (BSusCA) system. The assessment is generated with an appropriate formula for a pre-assessment benchmarking tool. Hence, it will allow practitioners to understand the minimum requirements for achieving green building certification. This research only focused on the Non-Residential Existing Building (NREB), which includes Chowrasta Market (Pasar Chowrasta) and Kompleks Dato' Kailan. This study adopted a mixed-method approach by means of questionnaires, case studies, interviews, surveys, and direct observations. The collected data was compared to the literature review. First, significant components of government assessment (pHJKR and SIRIM) and private benchmarking tools for existing building criteria (GBI) were compared. The outcomes indicated that achievement point benchmarks should at least reach 50% in each tool. Second, sub-criteria between pHJKR and GBI assessment tools for a reliable inspection were identified. GBI achieved the targeted benchmarks of ≥50 with an extra 5 points, whereas pHJKR's targeted benchmarks were ≥74 and achieved with an extra 13 points. Based on these analyses, a Visual/Protocol 1 Inspection Method for the BSusCA system was created with six (6) different criteria. In addition, thematic analysis was used to look at the results of the interview about the BSusCA, and professionals concluded that this case study should be continued for the benefit of stakeholders and practitioners.

Keywords: Green building, sustainable building assessment, pHJKR, SIRIM 2020

1.0 INTRODUCTION

The most serious environmental issues are considered to be global warming and environmental destruction. Climate change is the most serious environmental issue that humanity will face over the next decade (Iberdrola, n.d.). Due to these problems, the global construction industry is moving to emphasise the necessity of reducing greenhouse gas emissions by introducing green buildings (World Green Building Council). Thus, in this study, developing a Visual/Protocol 1 Inspection Tool for Building Sustainable Condition Assessment (BSusCA) system will allow building stakeholders to make precise decisions and plan towards achieving a sustainable agenda tailored to their current conditions. Additionally, this tool helps those working in the construction sector grasp the fundamental knowledge, time frame, and additional expenses needed to achieve green building certification. In summary, the BSusCA approach may be recommended as a valuable tool to assist novice users' decision-making and play a vital role in promoting the certification of green buildings.

In this study, one identified research problem is how sustainability in the building sector can be effectively tackled with undisputed facts and how a core principle of sustainable construction has proven its value (Darko & Chan, 2017). People may experience a variety of challenges, including unplanned events, a challenging qualification procedure, and urgent priority work, particularly if they are unfamiliar with the certification framework that must be used. Additionally, they do not consider how long it will take to finish the certification process. The aim of this research is to develop a Visual/Protocol 1 Inspection Method for Building Sustainable Condition Assessment (BSusCA) system that will allow stakeholders and practitioners participating in the construction industry to understand their minimum requirements to achieve green building certification in order to promote sustainability in the building industry and raise awareness among developers, architects, engineers, consultants, architects, contractors, and the public about environmental issues. The rating system will provide an incentive for architects to design and develop green, sustainable buildings that offer energy efficiency, water savings, a healthier indoor environment, greater access to public transport, greenery, and recycling for their designs. The appliances will be rewarded on the maximum criteria if they achieve the minimum total point of lowest certification. Obtaining marks in all targeted areas would indicate that the building would be more environmentally friendly than those that are not (Tan, 2009). In the GBI evaluation process framework, points will then be awarded for implementing environmentally friendly elements above and beyond the existing market standard. The evaluation process includes an assessment at the end of the design (Design Assessment – DA). The consequence is the award of the provisional GBI ranking. One year after the building's first occupancy (Completion and Verification Assessment – CVA) (Greenbuildingindex Sdn Bhd). Companies will also need to be re-assessed every three years to keep their GBI status in order to ensure that their buildings are well controlled (Wei, 2021). Buildings were awarded to GBI Malaysia-Platinum, Gold, Silver, or Graded Grades on the basis of the scores received (Yusoff & Wong, 2014). Competition among rating tools, especially if consumers are unsure which tool to use, may convey signals that promote confusion rather than demonstrate knowledge and react to environmental situations.

Therefore, prelim inspection (BSusCA) development is an essential tool to address the existing hurdles to make green building certification more appropriate from a person's perspective, leading to a rise in the number of green buildings approved. This initiative and the implementation of the new green building rating tools are expected to evolve substantially in the future. The BSusCA system can be recommended as an effective device to assist inexperienced user decision-making and play a key role in supporting green building certification. Prelims play an essential role in final preparation, which means something preliminary, an introductory or preparatory step to achieve fair work (Fowler & Rauch, 2006). Green building rating tools do not use any prelim or outcome in rating a sustainable building compared to the Building Condition Assessment (BCA-JKR), which already has prelims and full procedures that guide an assessment towards proper and good results. This method will enable building stakeholders to make specific choices and strategies toward achieving a sustainable agenda that is suited to their existing circumstances.

This research is concerned with helping stakeholders and professionals interested in the construction industry to understand their basic understanding, timeline, and additional costs required to enable green building certification. It can encourage customers to calculate additional costs, such as certification fees and contributions from third parties, based on the amount of time it takes to enforce the rating process at all levels concerned. It can also eliminate unintended or hidden expenses arising in the evaluation process. This conceptual framework (BsusCA) for the basic awareness of the rating instrument and the certification process should be improved regarding all equipment or descriptions of each credit condition. This research also provides an overview of dominant and significant national environmental benchmarking tools in the private and public sectors for NREB. There are two key criteria stated for NREB in the GBI that give different results: Energy Efficiency and Indoor Environmental Quality (W. M. Z. W. Sapiansori, personal communication, 2021), by which the private and public evaluation tools' approaches can be compared. Energy Efficiency, Indoor Environmental Quality, Water Efficiency, Sustainable Site Planning & Management, Innovation, and Materials & Resources are some of the significant observable criteria that can be used.

This approach identified that the new green building ranking tool considers the characteristics of efficiency, availability, and predictability of certified green buildings' sustainable outcomes relevant to knowledge, time, and expense. There are parties in the design industry who may not understand how to plan their project time and actual costs while implementing a lengthy certification process. This research objective is encouraged by summing up the formulating of a Visual/Protocol 1 Inspection Tool for Building Sustainable Condition Assessment (BSusCA) framework. Its goal is to identify the dominant or significant components of private and government environmental sustainability assessment tools for reliable inspection. Moreover, it intends to provide a simpler procedure for the pre-assessment of existing non-residential buildings that may be eligible for full accreditation.

2.0 LITERATURE REVIEW

2.1 Green Building

A green building can be described as a building that ensures the healthiest possible climate during its total service life while at the same time allowing the most effective and least destructive use of land, water, energy, and resources (World Green Building Council). Climatic architectural features; passive design elements and strategies for power generation, cooling, ventilation, and daylight; use of renewable energy sources; economically viable and environmentally sustainable construction practices; and post-occupation, use of vernacular materials, and emphasis on occupant wellbeing were among the primary requirements for identifying a green building. The building industry is now facing two huge challenges around the world. The first is the expensive use of energy from conventional sources. The second is the sort of ecological destruction that may arise as a result of design and activity, such as air, water, and soil pollution; carbon dioxide and other greenhouse gas emissions; and damage to the native ecosystem and other natural ecosystems. There is also a growing understanding, however, that green architecture will enable builders to respond to all of these challenges. Not only would it have a good impact on public health and the environment, but it might also reduce infrastructure costs, increase the marketability of buildings and businesses, boost the productivity of people, and help in the creation of a healthy society (Fowler & Rauch, 2006).

Malaysia's efforts to spur green building investment and demand, with a particular focus on the Green Building Index (GBI), and the enabling of green tax incentives (Aliagha et al., 2013). There are variables that have the potential to promote green construction in Malaysia as well as overcome obstacles and hurdles. Based on the review, it can be inferred that the Malaysian green tax incentives for obtaining GBI certification are significant but not outstanding. The analysis also enables us to hypothesise that the demand model for green buildings in Malaysia will consist of seven interrelated factors: the quest for environmental sustainability; the quest for increased productivity; the quest for improved internal building conditions; the quest for higher building value; the quest for cost savings; the quest for lower risks; and the quest for branding and prestige. The nature and strength of the relationship among the factors will be moderated by some of the challenges and barriers identified in the review (Aliagha et al., 2013). The 2021 World Green Building Trends study examines the many variables that are driving commitments to green building in regions where sustainable building assessment trends are prevalent (Dodge Construction Network, 2021). Surveyed industry professionals cite social and financial motivations for increasing their green building efforts, including lowering operating costs, lowering carbon emissions, reducing energy and water consumption, market demand, constructing healthier buildings, and meeting internal corporate commitments. Based on the review, most of the respondents stated that they have shifted their focus on strategies to specifically address reducing energy consumption and the carbon footprint (KeTTHA, 2017) of building projects with the goal of creating net-zero or net-positive buildings as the top priority. This realisation entails that the only way to reduce the consequences of climate change is to make the built environment carbon neutral.

This study also provides an overview and identifies dominant or significant national environmental benchmarking tools in the private and public sectors for NREB. There are two key criteria stated for NREB in the GBI: Energy Efficiency and Indoor Environmental Quality (W. M. Z. W. Sapiansori, personal communication, 2021), by which the private and public evaluation tools' approaches can be compared. The different observable significant criteria are Energy Efficiency, Indoor Environmental Quality, Water Efficiency, Sustainable Site Planning and Management, Innovation, and Materials and Resources.

In addition, this study addressed several obstacles in the pursuit of achieving green building. The first problem is insufficient knowledge. Lack of knowledge is also a barrier that can be seen in many respects, such as lack of knowledge and detail, lack of experience, and lack of understanding among the public and stakeholders in the building industry. This problem of awareness is the lack of strong evidence of reliable green building studies and a lack of learning. This scarcity of information may lead to a lack of public awareness and competence in green construction (Darko & Chan, 2017).

2.2 Features of Green Building

The World Green Building Council said that there are a variety of features that can make the building "green". This feature involves improved use of oil and water, as well as other services by means of renewable energy, such as solar energy, which transforms light energy from the sun into electricity, directly using photovoltaics and indirectly through concentrated solar power (World Green Building Council). This also involves increasing the area of the impervious surface, such as replacing areas (grass, trees, brush, etc.) with impervious areas (asphalt, concrete, roofs, etc.) and improving stormwater runoff (asphalt, concrete, ceilings, etc.) and mini-frame runoff, etc. (Faulhaber, n.d.). Other countries and regions have many characteristics, such as distinctive climatic conditions, remarkable cultures and traditions, varied development types and ages, and a wide variety of environmental, economic, and social priorities—all of which affect their green building approach. In addition, to achieve a structure adapted to a changing climate, priority should be given to the building as a green building (Faulhaber, n.d.) by considering the environment in the building, health and wellbeing of the tenants, installation, and activity in the preliminary stages.

2.3 Implementing Green Building Design for a Sustainable Future

The demand for sustainable buildings is expected to expand across the nation in all sectors. In addition, companies should continue to see improvements in building codes as sustainability requirements develop. When starting a new hospitality development project or a sustainable renovation project for any office building, it is crucial to collaborate with qualified professionals to create the most sustainable building designs. Several major corporations realise that companies have an important role to play in solving important environmental challenges. Of course, many executives of major venture companies tend to be serious about sustainability. Today, investors, fund managers, and sell-side analysts seldom approach major financial, social, and governance (ESG) companies that are out of date. Previously, ESG interviewed 70 senior executives at 43 large global investment companies, including the world's biggest three wealth managers (BlackRock, Vanguard, and State Street) and massive property investors, such as the California Public Employees' Retirement System (CalPERS), the California State Teachers' Retirement System (CalSTRS) and the Government Pension Systems of Japan and Sweden. ESG was widely seen as the top of the head for all these directors. It is worth repeating that investors have been discussing sustainability issues for many years (Eccles & Klimenko, 2019).

Statistics reinforce the argument that financial markets are in the middle of a sea change. When the UN-backed Principles for Wise Investing (PRI) were introduced in 2006, 63 financial institutions (asset owners, asset managers, and service providers) with $6.5 trillion in assets under management (AUM) expressed their willingness to integrate ESG concerns into their investment decisions. By April 2018, the number of signatory nations had risen to 1,715, totalling $81.7 trillion in AUM. According to the 2018 FTSE Russell Global Survey, more than half of global asset owners pursue a comprehensive investing plan or analysis of ESG variables. Yet somehow, the ultimate professionalism appears to be unaware of modern reality. In a new study by Merrill Lynch and Bank of America, U.S. executives underestimated the proportion of shares owned by businesses using green management strategies. The average estimate was 5%; the total percentage was more than 25% (Eccles & Klimenko, 2019).

2.4 Green Building Rating Tools

Greenhouse gases and ozone depletion were recurring themes during the 1992 Earth Summit in Rio (Climate Policy Watcher, 2022). In the 1990s, the first version of the Building Research Environmental Assessment Method (BREEAM) was introduced in the United Kingdom (UK) (Cordero et al., 2020). In 1996, Leadership in Energy and Environmental Design (LEED) (Cordero et al., 2020), one of the most well-known green building rating systems, was introduced in the United States (USA) (Tan, 2009). This was the result of the realisation that buildings and the built environment had contributed significantly to greenhouse gas pollution and thus needed to be altered to decrease their adverse impact on the earth. The concept that buildings are "machines for life" has been shown to be accurate, and structures may survive a long time and contribute to environmental degradation throughout that time (Leong, 2010). As a consequence, the completed product will operate effectively in its intended use while simultaneously causing more harm to the environment. By design and intent, green ranking algorithms are very reliant on the climate and ecology, and hence the environment. A quick review of the new Green Rating tools available around the globe today will reveal that they are all centred in climatic zones with moderate temperatures (Vierra, 2022). As indicated in Figure 1, others include the well-known UK BREEAM, US LEED, Japan's CASBEE, and Australia's GREENSTAR.

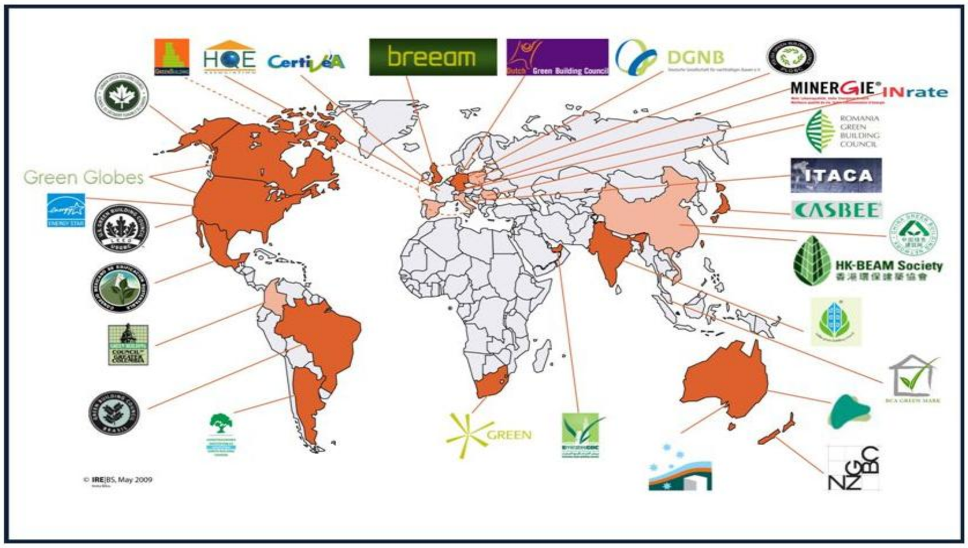


Figure 1 Various sustainable tools around the world
Source: Reed et al. (2009)

The Malaysian Green Building Index, or GBI, will be the biggest building zone ranking tool other than Singapore's GREENMARK (Tan, 2009). After the implementation of the GBI in 2008, 504 projects in Malaysia have achieved (as of December 2017) a GBI ranking with various accredited titles such as the GBI Non-Residential New Construction (NRNC) Tool, the GBI Residential New Construction (RNC), the GBI Non-Residential Existing Building (NREB), the Industrial Existing Building (IEB), the Interior (I.D.), and the Township of Malaysia (T). Kuala Lumpur is the state with the largest number of applications registered for the GBI Programme, whereas Perlis and Labuan also do not qualify for any GBI for any house. It was from this situation that an ideal method for developing some standard features of traditional models in the study field has been considered (KeTTHA, 2017).

2.5 Green Building Index, Malaysia

The Green Building Index (GBI) is a green building ranking developed by Pertubuhan Arkitek Malaysia/Malaysian Institute of Architects (PAM) and the Malaysia Consulting Engineers Association (ACEM) (Tan, 2009). GBI was launched in 2009 and has completed an estimated total of almost 100 million square feet of buildings over the last five years. GBI and the Malaysian Green Building Council have significantly increased awareness of the importance of green buildings among all core stakeholders, including building owners, architects, engineers, and building developers. Green Building Index (GBI) is a formal measurement instrument for assessing the environmental design and performance of buildings in the following areas: Energy Efficiency (EE), Indoor Environmental Quality (EQ), Sustainable Site Planning & Management (SM), Material and Resources (MR), Water Efficiency (WE), and Innovation (IN) (Greenbuildingindex Sdn Bhd, 2011b).

2.6 pHJKR and SIRIM 2020

This standard emphasises seven important sustainable site planning and management components: management of energy efficiency; management of resources and materials; water usage efficiency; internal environmental quality; sustainable facilities; and innovative design. Regarding design and construction activities, pHJKR consists of 43 sub-criteria (Zakaria, 2020). Table 1 shows the classification of the proportion of green ratings for residential and non-residential structures.

Table 1 SIRIM 2020 rating classification

Percentage (%)	Green Rating
80–100	Global Excellence
65–79	National Excellent
45–64	Best Management Practices
30–44	Recognition Potential
Less than 29	Certification of Participation

Green element application is a simulation of either active or passive design (Gallego & Anyosa, 2019) and building energy consumption. The application of SPAH system evaluation will centre on the efficacy of rainwater collection and reuse (Musa et al., 2017). In addition, renewable energy and innovations such as technology motion sensor/dual sensor/BAS/water leakage sensor will increase the proportion of a building's green rating stage (Lee & Kim, 2020). In addition, landscaping will be included in the Design Evaluation Phase. In addition to evaluating the building's performance, the landscape design criteria of open spaces, landscaping, and heat island effect have become an integral part of the overall GBI evaluation (Nizarudin et al., 2011). The green element's construction phase (DOE, 2016) must be implemented on-site and evidence documents must be gathered. followed by the submission of a user manual, as-built or preventive plan maintenance, and VP Assessment evaluation. Once task 31 is completed, the building can be occupied to ensure that it always functions properly and that the occupants are satisfied, monitored, and maintained. Any restoration, renovation, or upgrade project requires a detailed plan. The primary objective of operation and maintenance is to protect, supervise, and maintain the building during the VP Assessment period.

The implementation procedures of pHJKR assessment comprises of four (4) stages of process flow. Initially, the registration should be carried out at the project planning stage as shown in Figure 2. The validity period of registration is two (2) years. The design evaluation process needs to be implemented within that period. However, an extension of the period can be applied for by the project team leader based on the progress of project implementation.

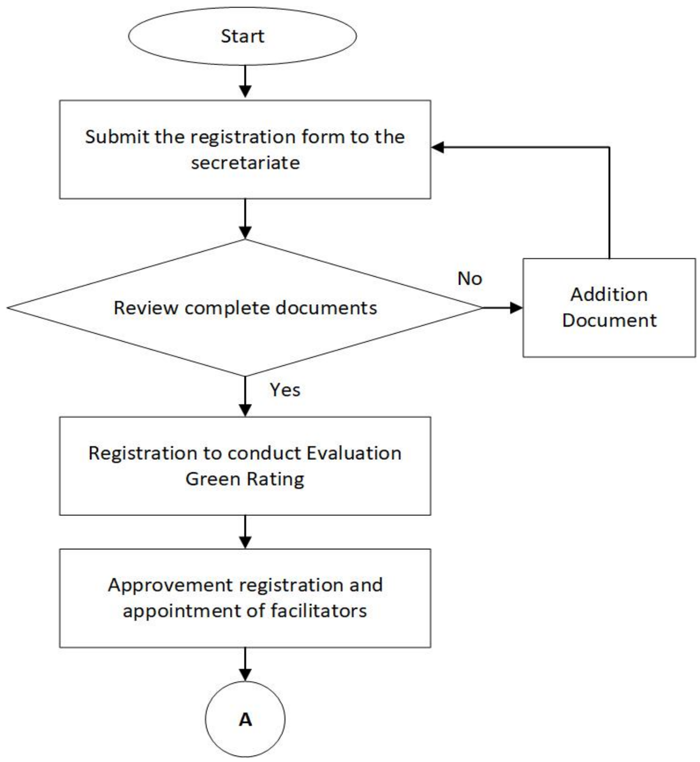


Figure 2 Stage 1 – Application and registration
Source: Jabatan Kerja Raya and SIRIM Berhad (2018)

Prior to the issuance of the conditional rating certificate, there will be a random audit of the self-assessment as shown in Figure 3. The facilitator and project team leader are responsible for obtaining results based on a joint evaluation of the project team, while the project team leader is responsible for submitting the results of the evaluation done with the project team along with supporting documentation. Three years is the duration of validity for the rating certificate. The re-rating is conducted within six months of the expiration of the rating certificate. The secretariat will also only issue rating certificates for ratings of three stars or less.

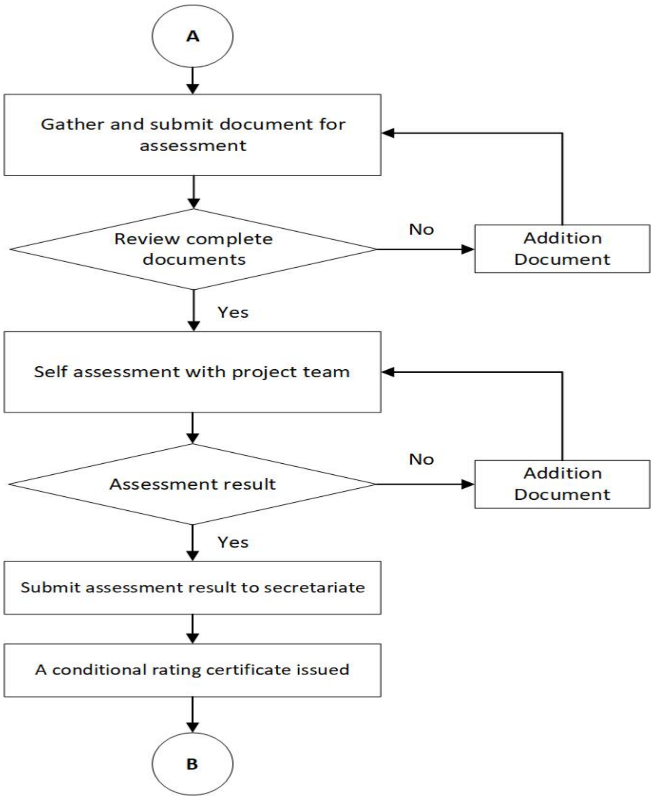


Figure 3 Stage 2 – Design evaluation
Source: Source: Jabatan Kerja Raya and SIRIM Berhad (2018)

The third stage is the verification of result, whereby the rating certificates issued in the stage by a secretariat are 3-star rating and below.

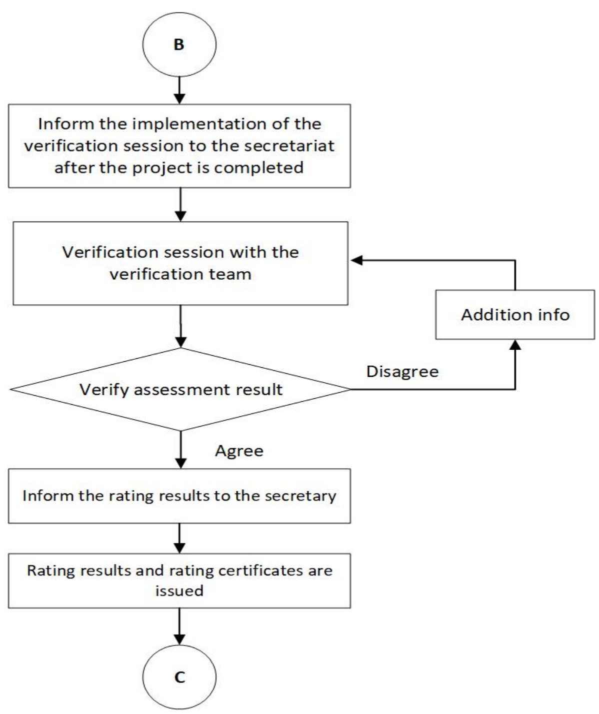


Figure 4 Stage 3 – Scoring assessment
Source: Source: Jabatan Kerja Raya and SIRIM Berhad (2018)

For ratings of four stars and higher, the subsequent validation procedure is required. Figure 5 depicts the details accordingly.

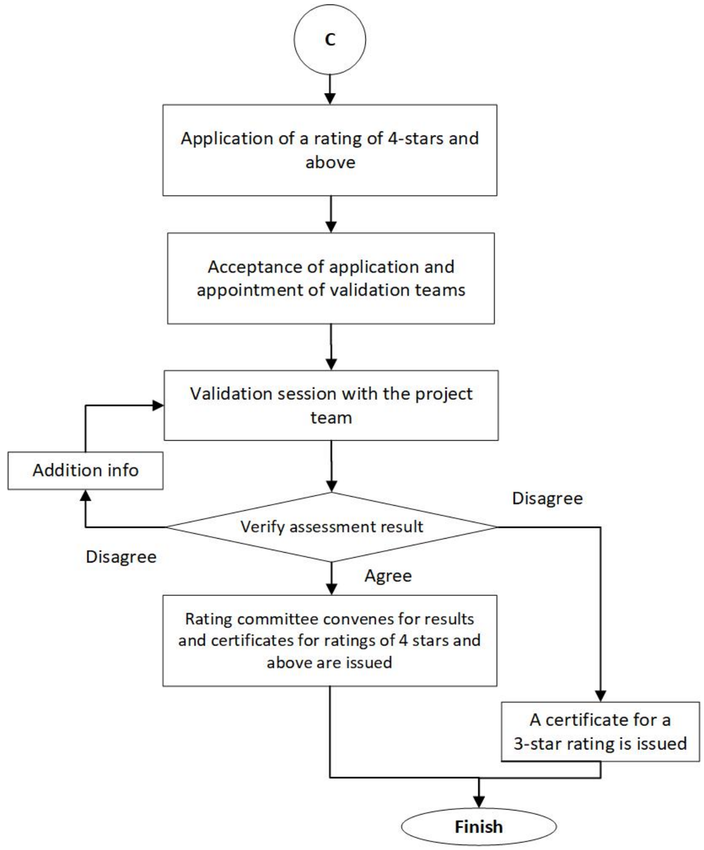


Figure 5 Stage 4 – Scoring validation
Source: Source: Jabatan Kerja Raya and SIRIM Berhad (2018)

3.0 METHODOLOGY

3.1 Data Collection

This method of research is implemented by using a mixed-method approach. First, this study utilised data collection techniques, site survey and expert interviews to examine the validation of the new checklist created in pre-assessment on potential full accreditation of selected Non-Residential Existing Building (NREB). The method combines and compares the essential components in between private and government-sustainable assessment tools for a reliable inspection. Next is the interview technique, via snowball technique, conducted with 8 professionals to identify the validation of the checklist created. The interview is to obtain agreement and feedback from professionals, particularly the design team and project managers, on the limited knowledge of each GBI credit in Malaysia, time spent during the qualification process, and hidden costs associated with the specific selection criteria.

3.1.1 Site Survey

A site survey is one of the data collection methods utilised in this study. Visit a certified sustainable building in Penang to collect raw data and submit a report to the city council. The technique used for sampling is based on subjective evaluation (or purposive). Since the objective is to identify dominant and significant components of national environmental sustainability assessment and benchmarking tools for existing buildings, the focus will be centred on pHJKR and Green Building Index.

This field research focuses on two existing non-residential buildings (NREB) in Malaysia. Both selected case studies are located in Penang, Malaysia, where Building 1 is the only existing non-residential structure certified by a private sustainable rating tool, GBI. Building 2 is a non-residential real estate building (NREB) that made no effort to obtain certification, but it contains several potential sustainable buildings, including Chowrasta Market and Kompleks Dato' Kailan. During the site survey at the Chowrasta Market, a variety of sustainable methods and tools were discovered, including handicap parking lot ramps, open halls, solar panels, rainwater harvesting, compact fluorescents, and polycarbonate roofs. The following structure was Kompleks Dato' Kailan, which featured sustainable Corridor Walkway, Passive Cooling, Split Unit Aircon & Lighting Zoning, Polycarbonate Roof, Window Opening, and Stairway to First Floor features. The sustainable elements are described in detail in Tables 2 and 3. The Snowball technique is utilised to validate the created checklist for the chosen case study. Existing subjects provide referrals in order to recruit the samples necessary for a research study using this sampling technique. The checklist is a pre-assessment technique that aims to aid building owners in achieving the points required by sustainable rating tools. From the chosen case studies, all the gathered information on green certification documents was gleaned. This method aims to create a database of a standard model that has been certified as a green building and compare it to a case study model with the most comparable or pertinent characteristics. This information is then compared to the building records for similarities or shared characteristics. It is known that the documentation requirement clarifies the records or specifics pertaining to the time required by each credit in the certification process, the existence of additional costs, and the level of certification or recognition attained. Therefore, a simplified pre-assessment is created based on the site visit data analysis in conjunction with the literature review abstract data collection.

3.2 Expert Interviews

The expert interview technique adopts the snowball technique, which is well trained for the Green Rating Tool, and the project manager, and the design team and construction engineers and designers. This interview focuses on the validation of the created checklist made for the pre-assessment of green building certification. This is a sampling technique in which existing subjects provide referrals to recruit samples required for the research study. The checklist is the pre-assessment method which aims to assist the building owners in achieving points as requested in the sustainable rating tools. The interview is to gain agreement and comments from participants, particularly the design team and project managers, on limited knowledge of each GBT credit in Malaysia, time spent during the qualification process, and hidden costs on the specific selection criteria.

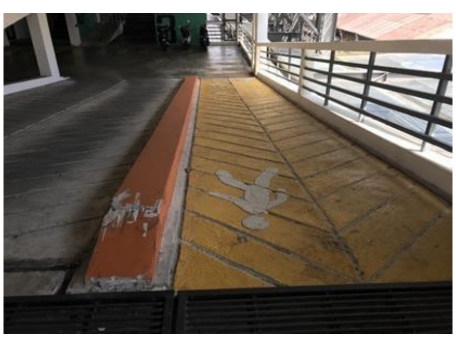
The analysis technique for interview data is a thematic analysis highlighting the verbatim quotations from the informants necessary to reflect the supporting evidence for the research findings. Thematic analysis is one of the most effective methods of analysing qualitative studies. It is a method for identifying, analysing, organising, describing, and recording trends found in the processing of data (Braun & Clarke, 2012). This study would be done through thematic regression to interpret the outcomes of the interview.

4.0 RESULT AND DISCUSSION

The selection of two building case studies is based on the similarity in building types between Kompleks Dato' Kailan and Chowrasta Market building, which are non-residential existing buildings, which form the main element of the research area. Chowrasta Market, Penang, is the only Non-Residential Existing Building that is certified as a green building because it successfully collected points and was awarded a silver level certificate by Green Building Index. The total area is 2,413.56 m² (25,979.35 ft²). Chowrasta Market has been undergoing restoration for several years since 2012 and was completed in 2017. Kompleks Dato' Kailan is located in Jalan Perusahaan 1, 13100 Kepala Batas, Pulau Pinang, with a total area of 3,137.92 m² (33,776.32 ft²). Furthermore, Kompleks Dato' Kailan is a Non-Residential Existing Building, which serves as a shopping complex in the heart of Kepala Batas. The project is still under refurbishment conducted by JKP Sdn Bhd. Survey findings are discussed under various subsection headings as follows.

4.1 Site Visit on Sustainable Elements

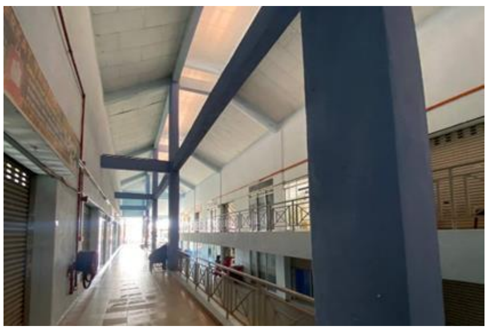
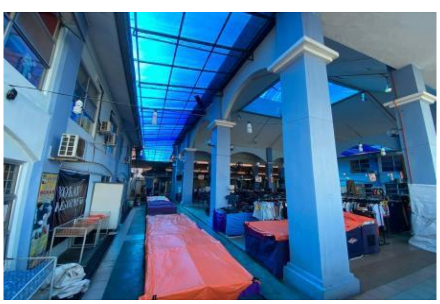
Table 2 Chowrasta Market (Pasar Chowrasta), Penang Site Visit

No	Figure	Description
1		**Handicap Parking Lot Ramps** • The ramp will boost accessibility, empowering the physically disabled to enter building facility without any encumbrance.

2		**Open Hall** • Daylighting is to minimise the amount of artificial light and reduce electricity costs, but it can also lower HVAC costs as well.
3		**Solar Panel** • Solar power is used to reduce dependence on foreign oil and fossil fuels. Renewable clean power is available every day of the year; even cloudy days produce some power.
4		**Rainwater Harvesting** • Harvesting and reusing rainwater reduces the building's need for water from the mains.
5		**Compact Fluorescent** • Electric lighting controls are used in lighting design projects to achieve a high-quality energy-efficient lighting system.

6		**Polycarbonate Roof** • Polycarbonate scores highly in terms of sustainability. It has a long service lifespan, and the panels are fully recyclable.

Table 3 Kompleks Dato' Kailan, Penang Site Visit

No	Figure	Description
1		**Corridor Walkway** • The size and placement of these openings are used to guide air into and through the building.
2		**Passive Cooling** • The flow of external air into an indoor space as a result of pressure differences arising from natural forces.
3		**Split Unit Air Conditioner & Lighting Zoning** • Split systems increase energy savings and reduce money spent on utility bills. Electric lighting zoning controls are used in lighting systems to achieve a high-quality energy-efficient lighting system.

4		**Polycarbonate Roof** • The properties of polycarbonate make it the ideal material for the construction of greenhouses.
5		**Window Opening** • Window openings serve the functions of natural light, natural ventilation, and vision. Daylight in the building reduces the need for artificial lighting.
6		**Stairway to First Floor** • Stairway leading to the first floor with a good airflow directly from the lobby.

4.2 Dominant/Significant Components of National Environmental Sustainability Assessment and Benchmarking Tools for Existing Buildings

The primary objective of this study's research is to identify the dominant and significant components of private and government environmental sustainability assessments. In this instance, the research objective 1 (RO1) method is compared to green building index certification evaluation criteria that overlap with pHJKR criteria. The analysis reveals the identification of dominant criteria between private and government sustainable tools for achieving certification as a sustainable structure. Energy Efficiency and Indoor Environmental Quality are the two significant criteria listed for NREB in GBI (Greenbuildingindex Sdn Bhd, 2011b). There is a similarity between sustainable building tools of private and government requirements, where the achievement point benchmarks must be at least 50% in GBI (Greenbuildingindex Sdn Bhd, 2011a) and a minimum benchmark of ≥ 68 in pHJKR.

Table 4 below shows the dominant or significant components of the national environmental sustainability assessment and benchmarking tools for NREB ranked according to the highest points.

Table 4 Significant components
(Source: Rashid et al., 2011)

NO	CODE	Criteria	GBI	SIRIM
1	EE	Energy Efficiency	38	50
2	EQ	Indoor Environmental Quality	21	29
3	WE	Water Efficiency	12	22
4	SM	Sustainable Site Planning & Management	10	18
5	IN	Innovation	10	6
6	MR	Materials & Resources	9	4

4.3 Essential Environmental Sustainability Subcomponents for Reliable Inspection

The analysis approach is by combining the included criteria that contribute points in the GBI certification evaluation to Building 1, which will be mentioned in the table as (CS), and the overlapping sub-criteria listed in pHJKR as shown in Table 5. This method shows the identification of dominant criteria in sustainable tools in critically achieving certification as a sustainable building.

The table below summarises the total number of points obtained from the essential and optional sub-criteria. With an additional 5 points, the GBI sub-criteria has reached the targeted benchmarks of ≥50 (Greenbuildingindex Sdn Bhd, 2011b). The pHJKR target benchmarks of ≥74 have been met with an additional 13 points.

Table 5 Total essential sub-criteria points achieved by GBI and pHJKR

		GBI					pHJKR			
Code	Criteria	Actual Point	Eliminated Items	Building 1 Score	Required for Compliance (50%)	Essential	Actual Point	Eliminated Items	Required for Compliance (50%)	Essential
EE	Energy Efficiency	38	EE4, EE8	31	19	19	50	EE2, EE3, EE8, EE9, EE10	25	31
EQ	Indoor Environmental Quality	21	EQ6, EQ7, EQ13	12	11	14	29	EQ2(1,2), EQ3(2,5), EQ7	15	25
SM	Sustainable Site Planning and Management	16	SM1	6	8	6	18	SM4(1,5)	9	13
MR	Materials & Resources	11	MR3, MR6	8	6	6	4	-	2	4
WE	Water Efficiency	12	WE2, WE3	8	6	6	22	WE3(2), WE4	11	11
IN	Innovation	10	-	4	5	4	6	-	3	3
Total Points						55				87

4.4 BSusCA Pre-Assessment Checklist on Selected Non-Residential Existing Building

Below is the simplified pre-assessment checklist on potential full accreditation of selected Non-Residential Existing Building. Thematic analysis was used to examine the validity of the finalised checklist. As the feedback received was in favour of the proposed content of the checklist, the interview was concluded after 8 respondents deemed it had reached the saturation level. Comments on formulated pre-assessment building sustainable condition assessments were compiled and finalised in Table 6 until Table 11, based on the objectives of this research as mentioned earlier in this paper.

Thus, Tables 6 to 11 show that the pre-assessment checklist on selected Non-Residential Existing Building uses methods such as Green Building Index (GBI) as a formal measurement for measuring the environmental design and performance of buildings, with criteria such as Energy Efficiency (EE), Indoor Environmental Quality (EQ), Sustainable Site Planning & Management (SM), Materials and Resources (MR), Water Efficiency (WE), and Innovation (IN) (Greenbuildingindex Sdn Bhd, 2011b).

Table 6 BSusCA pre-assessment checklist on selected non-residential existing building's energy efficiency

Criteria 1: Energy Efficiency					
No. (EE)	**Item**	**Description**		**Compliance (/)**	**Remarks**
EE1	Minimum EE Performance	1.1	OTTV & RTTV		
		1.2	Energy Management System		
EE2	Lighting Efficiency	2.1	Lighting Zone		
		2.2	Lighting Control		
		2.3	(LPD) / (LPI)		
EE3	Building Orientation	3.1	Minimise openings		
EE4	Electric Sub-metering	4.1	Auto sensor-controlled lighting		
EE5	BEI	5.1	Improved EE Performance		
EE6	Enhanced or Re-commissioning	6.1	Functionality and the effectiveness building's energy performance		
EE7	On-going Post Occupancy Commissioning	7.1	Declaration that post occupancy commissioning		
EE8	Sustainable Maintenance	8.1	Building's energy related systems continue to perform		
EE9	Air Conditioning and Mechanical Ventilation System (ACMV)	9.1	Coefficient of Performance (COP)		
		9.2	Green refrigerant		

Table 7 BSusCA pre-assessment checklist on selected non-residential existing building's indoor environmental quality

Criteria 2: Indoor Environmental Quality					
No. (EQ)	**Item**	**Description**		**Compliance (/)**	**Remarks**
EQ1	IAQ Performance	1.1	Minimum (IAQ) performance		
		1.2	Volatile Organic Compound (VOC)		
		1.3	Reduce Detrimental Impact		
EQ2	IAQ Before and During Occupancy	2.1	Comfort and well-being of building occupants		
EQ3	Environmental Tobacco Smoke (ETS) Control	3.1	Minimise exposure, ventilation air distribution systems, and smoking areas		
EQ4	Planning Space	4.1	Light transparent		
		4.2	Ceiling height		
		4.3	Bright colours on wall and ceiling surfaces		
EQ5	Carbon Dioxide Monitoring and Control	5.1	Monitoring of carbon dioxide levels ensure delivery of minimum outside air		
EQ6	Mould Prevention	6.1	Indoor air humidity		
EQ7	Visual Quality	7.1	Daylight Factor		
		7.2	Daylight Glare Control		
		7.3	Visual Access		
EQ8	High Frequency Ballasts	8.1	Install high frequency ballasts in fluorescent luminaires		
EQ9	Post Occupancy Comfort Survey: Verification	9.1	Comfort of the building occupants		

Table 8 BSusCA pre-assessment checklist on selected non-residential existing building's sustainable site planning and management

Criteria 3: Sustainable Site Planning & Management					
No. (SM)	**Item**	**Description**		**Compliance (/)**	**Remarks**
SM1	Building Exterior Management	1.1	Use environmentally non-polluting methods and chemicals		
SM2	Integrated Pest Management, Erosion Control & Landscape Management	2.1	• Preserve ecological integrity, enhance natural diversity and protect wildlife • Maintain stability and reduce erosion of existing slopes		
SM3	Rainwater management	3.1	Maintain stormwater management		
SM4	Green Vehicle Priority	4.1	Provide preferred parking		
SM5	Parking Capacity	5.1	• Minimum local zoning requirements, AND • Vanpools for 5% of the total provided parking spaces		
SM6	Greenery Roof and Walls	6.1	• Hardscape & Greenery Application • Roof Application		
SM7	Building User Manual	7.1	Documents all the passive and active features		
SM8	Design, accessibility, and facilities for the disabled	8.1	Accessibility and facilities for the disabled (OKU)		

Table 9 BSusCA pre-assessment checklist on selected non-residential existing building's materials and resources

Criteria 4: Materials and Resources					
No. (MR)	**Item**	**Description**		**Compliance (/)**	**Remarks**
MR1	Materials Reuse and Selection	1.1	Integrate building design and its buildability		
MR2	Recycled Content Materials	2.1	Increase demand for building products that incorporate recycled content materials in the production		
MR3	Sustainable Purchasing Policy	3.1	Product purchase within the building and management's control		

MR4	Storage, Collection & Disposal of Recyclable	4.1	• Collection of recyclable waste for recycling during disposal process • Waste minimisation and recycling • Waste sorting		

Table 10 BSusCA pre-assessment checklist on selected non-residential existing building's water efficiency

Criteria 5: Water Efficiency					
No. (WE)	**Item**	**Description**		**Compliance (/)**	**Remarks**
WE1	Rainwater Harvesting (SPAH)	1.1	Rainwater collection reduction of potable water consumption		
WE2	Water Efficient Fittings	2.1	Reduction annual potable water consumption		
WE3	Metering & Leak Detection System	3.1	Design of systems		
WE4	Water Efficiency Products	4.1	Water Efficient Product Labelling Scheme (WEPLS)		
WE5	Water Efficient Irrigation / Landscaping	5.1	Design of system that does not require the use of potable water supply from the local water authority		

Table 11 BSusCA pre-assessment checklist on selected non-residential existing building's innovation

Criteria 6: Innovation					
No. (IN)	**Item**	**Description**		**Compliance (/)**	**Remarks**
IN1	Rainwater Harvesting (SPAH)	1.1	Innovative technologies that include design and technology		
IN2	Water Efficient Fittings	2.1	Facilitator engaged at the onset of the design process until completion		

There is a recommendation to conduct additional research on the preparation of a pre-assessment building sustainable condition assessment checklist for other types of existing buildings or industries. Aside from that, it is recommended that every building owner use the same formulation method when creating their checklist, as each building has its own unique characteristics that may contribute more points to the existing sustainable criteria. In addition, there are few specific recommendations for the government to encourage and facilitate the participation of stakeholders and practitioners in registering their buildings for assessment as sustainable buildings. The final recommendation for the government is to subsidise professional and specialised green building courses and processes.

This study employed two case studies. The Chowrasta Market is the first certified sustainable building in Penang. Kompleks Dato' Kailan is a building with a unique identity that has the potential to be certified as a sustainable structure. The objective of this study is to develop a system that will enable stakeholders and practitioners in the construction industry to comprehend the minimal requirements necessary to obtain green building certification. The Green Building Index has six criteria, while SIRIM 2020 has seven. It requires considerable effort to guide the real estate industry to become more environmentally conscious. It also aims to promote sustainability in the construction industry and raise environmental awareness among developers, architects, engineers, consultants, contractors, and the general public. There are a number of important reasons for developing green and sustainable construction methods, and there is also an excellent opportunity for industry growth. Engineers can assist in a variety of ways by "greening" the layout of commercial and industrial buildings during the development process or by redesigning existing facilities by planning and constructing energy-efficient structures to reduce overall maintenance costs and energy consumption over the lifetime of the building. By optimising designs for material efficiency and removing building materials, waste can be reduced (Nationwide Construction, 2016).

The rating system will provide architects with an incentive to design green, sustainable buildings that provide energy efficiency, water savings, a healthier indoor environment, greater access to public transportation, greenery, and recycling (Vierra, 2022). The appliances will be rewarded based on the maximum criteria if they meet the minimum certification requirements. This research aims to assist construction industry stakeholders and professionals in understanding the basic knowledge, timeline, and additional costs required to enable green building certification. The research methodology employed in this instance is a mixed-methods strategy. This study will employ survey and interview methods to examine the validity of the new checklist developed for the pre-assessment of potential full accreditation for a subset of Non-Residential Existing Building.

All of the above-mentioned finding results have been addressed as the primary activities to be undertaken in order to obtain information pertaining to this research. The analysis approach is to ensure that the collection of data obtained from online sources is adequate and that nothing remains to be done. Data and information approaches will be defined and explained in detail using the following: 3) Analysis of sustainable building case study reports, 4) Application of the BSusCA Pre-Assessment Checklist to selected Non-Residential Existing Buildings, 5) Elaboration of the BSusCA Pre-Assessment Checklist, 6) Validation of the BSusCA Pre-Assessment Checklist, and 7) Thematic Analysis.

5.0 CONCLUSION

This study described minimum benchmarks in order to provide a method for formulating pre-assessment. The evaluation is anticipated to play a crucial role in the use of the green building rating system by providing an efficient method for making decisions and promoting certifications for sustainable buildings. The rating system will provide architects with an incentive to design and construct green, sustainable buildings that offer energy efficiency, water savings, a healthier indoor environment, greater access to public transportation, landscaping, and recycling. In addition, educating owners on the future benefits of green buildings is crucial because each green building plays a crucial role in achieving the goal of sustainable development, which is to protect the environment and enhance the quality of human life. Consequently, formulating pre-assessment BSusCA could be an effective mechanism for making green building certification more acceptable to the general public, leading to an increase in the number of green buildings that have been certified. The government also plays an important role in this case by attracting interest and providing facilities for stakeholders and practitioners to register their building for access as a sustainable building and participate. In addition, the government can subsidise green building professionals and specialised courses and processes. For a sustainable future, the demand for sustainable buildings can increase in all sectors of the nation. Energy Efficiency, Indoor Environmental Quality, Water Efficiency, Sustainable Site Planning & Management, Innovation, and Materials & Resources are notable criteria. Green building has multiple benefits for achieving a variety of global goals, such as combating climate change, creating sustainable and thriving communities, and fostering economic expansion. Consequently, green building can have a significant impact on the environment, economy, and society.

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