A framework of sustainability refurbishment assessment for heritage buildings in Malaysia

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Abstract. In view of the increasing initiatives of carbon emission reduction required by various countries, existing buildings often serve an important target in reducing energy consumption through building refurbishment to achieve sustainability. Nevertheless, less attention has been given to heritage buildings although previous studies claimed that energy consumption in heritage buildings can be reduced through refurbishing. How green assessment can be incorporated into heritage buildings remains unclear. Most of the existing assessment schemes focused on existing domestic and non-domestic buildings. There is lacking of a refurbishment assessment scheme targeted on heritage buildings. Hence, the aim of this study is to propose a framework that can be used to assess the refurbishment of heritage buildings which integrate the important assessment dimensions such as environmental, social, economic, heritage and conservation. This study compares eleven prominent assessment schemes such as BREEAM, LEED, BEAM Plus, CASBEE, GBLS, HQE, GBI, Green Mark, MyCrest, Green Star, and GBC Historic building. Fifteen assessment themes were identified that are related to refurbishment: management, transport, energy, indoor environmental quality, material, water, sustainable site, waste, innovation, pollution, culture, social, economic, quality of services and heritage value. Most of the assessment schemes focus on the assessment on environmental aspects, less attention given to economic, social and heritage aspects. None of these existing assessment schemes integrate all the relevant assessment themes for heritage buildings refurbishment. A framework for the development of a refurbishment scheme for heritage buildings is proposed in the next stage. The findings of this study could refer by the policy makers for formulating relevant guidelines and policies for ensuring best refurbishment practices for heritage buildings. This research could potentially transform the Malaysian heritage industry in conserving and refurbishing existing heritage buildings by improving environmental sustainability, cut carbon emissions and enhancing building conditions. This in turn could help in achieving the sustainability goal of the country as stipulated in the United Nation Sustainable Development Goals (UNSDG).

1. Introduction
Global warming, greenhouse gases (GHG) emission, climate change and pollution have raised the alarm around the world which demand immediate action to rectify the impacts on the natural environment. The building industry appears to be one of the major consumers in natural resources and its environmental impacts is enormous in term of carbon emission and energy consumption. The Malaysian government has targeted to cut down 45% of carbon emission by 2030 [1]. To achieve this goal, a
dramatic decrease in carbon emission and energy consumption especially from existing building can be targeted. Existing buildings has been discovered can achieve 15-25% of energy saving through best practices in energy efficiency [2]. One of the potentials for reducing energy consumption would be refurbishing the existing buildings [3]. Therefore, existing buildings are viewed as a key target due to their huge potential in reducing energy consumption.

The real estate and property markets are dominated by existing buildings due to existing buildings last a long period. Hence, refurbishment of existing buildings can enhance the building appearance, extend the life of the building, and improve comfort, health and safety of the building which eventually could increase the building’s capital value [4]. In particular, heritage buildings constitute part of the whole building stocks. In Malaysia, the presences of the unique heritage buildings in various states such as Kuala Lumpur, Georgetown and Malacca contain valuable historical and architectural values which require special care and protection. However, these buildings were not built sustainably which consume large amount of energy, poor ventilation and air quality. Moreover, existing heritage buildings are deteriorating caused by age which resulted in costly to maintain. Thus, these buildings demolished due to rapid development and lacking of new lands for new development. Webb [5] pointed out that heritage building refurbishment could help to reduce GHG emission and energy consumption. Hence, the heritage buildings stock could reduce environmental burden and achieve sustainability. However, how green initiatives can be incorporated into heritage buildings remains unclear [6]. It is challenging to refurbishment existing heritage buildings due to their unique physical appearance and heritage values.

Green Building Index (GBI) is one of the popular assessment schemes in Malaysia for assessing new and existing buildings’ performance. Besides that, Public Word Department has launched a Malaysian Carbon Reduction and Environmental Sustainability Tool (MyCrest). However, these two assessment schemes are not specified schemes that can be used to evaluate refurbished buildings especially for heritage buildings. Using an individual assessment scheme to assess all types of building including heritage building is insufficient [7] as some of the assessment criteria are not applicable for heritage buildings. It appeared that an assessment schemes for other building types as majority of the existing studies focused on residential buildings, office buildings and neighborhood [8]. In view of that, an assessment framework for heritage buildings is imperative to govern the best practices of refurbishment in Malaysia.

A wide of range of research has been conducted to compare the existing assessment schemes [8, 9, 10, 11, 12] in terms of assessment features, structures and weighting. However, limited research has been conducted on developing a refurbishment assessment framework for heritage buildings. Hence, the present study intends to develop an assessment framework for the government and green professional bodies to evaluate the performance of heritage buildings in Malaysia. It will be an aid to enhance sustainability in Malaysia’s refurbishment sector, at the same time to achieve the 45% of carbon emission reduction target.

2. Research Methodology
This research proposed 4-stage research process for developing the assessment framework as shown in Figure 1.

![Figure 1](image-url)
At stage 1, a comprehensive review was carried out from various previous studies [11, 12, 13, 14] to compile a list of assessment themes and sub-themes that relevant to assess heritage building refurbishment. Then, a comparative study of well-known assessment schemes was conducted. This study reviewed the literature on well-known assessment schemes from different regions such as BREEAM [15], LEED [16], CASBEE [17], BEAM Plus [18], HQE [19], GBLS [20], Green Mark [21], GBC Historic Building [22], Green Star [23], GBI [24] and MyCrest [25]. The selection of these assessment schemes was based on the popularity of the scheme and easy access to the assessment guidelines. Any new assessment theme and sub-theme that appears in the selected assessment schemes will add into the preliminary list, ensuring an updated assessment list.

Then, the updated assessment list will be filtered at stage 2 of the research process through Delphi approach. Delphi experts who are experienced in refurbishment practice and heritage building conservation will be selected for participating in the Delphi surveys. At this stage, relevant assessment themes and sub-themes that appropriate for assessing heritage buildings refurbishment will be determined. Next, Analytic Hierarchy Process (AHP) will be carried out by allocating assessment points or weightages. At stage 4, the developed assessment framework will be validated through few case studies. This is an on-going research and thus, only the research findings at stage 1 will be reported in this paper.

3. Results and Discussion
The literature review revealed that fifteen assessment themes that grouped under four dimensions which are environmental, heritage, economic, and social as illustrated in Figure 2. The environmental dimension consisted of management, sustainable site, transport, indoor environmental quality, energy, waste, material, water and pollution. Heritage dimension has two criteria namely heritage value and cultural. Economics and social dimension has economic and social criteria.

![Figure 2. Assessment dimensions for refurbished heritage buildings.](image)

The management theme assesses the operation and maintenance of a building throughout the project lifecycle from the conceptual stage, design development, construction stage, to building handover [13]. It is crucial to engage sustainability practices throughout the building lifecycle. The second assessment theme identified is a sustainable site, which assesses the site location, protection and ecological value. It is to avoid inappropriate development and minimize the impacts of construction on the ecosystem. The transport theme assesses the proximity of public transport and public amenities to the site. Walking and cycling are encouraged to reduce air pollution and traffic congestion from the use of private vehicles.
Indoor Environmental Quality (IEQ) is considered and included broadly in building assessment schemes, to increase comfort and improve the health and safety of a building’s occupants [13]. This included increased daylight, allow fresh air, improve thermal comfort in order to reduce sick building syndrome. Selection of building materials is considered one of the important themes starting from raw materials extraction, delivery and transportation, until the disposal of the end product [13].

Energy appears to be one of the most popular and important assessment themes, with emphasis on the energy performance of major building services, energy management and use of natural resources. The energy performance of the building services (air-conditioning system, car park, lift, external lighting, roofing and building envelope) is crucial to be evaluated to determine the amounts of energy saving and reduction by refurbishment. In the water theme, the purpose of water assessment it to reduce fresh water consumption to achieve sustainable water use. It can be achieved through water metering and monitoring, detection of leaks, and use of efficient fittings. Water recycling by using rainwater harvesting and grey water recycling, is important in minimizing water usage. The waste theme is included as one of the assessment themes to manage the waste efficiently in construction site and building. Waste management is essential to facilitate waste collection, recycling and disposal to ensure a clean environment.

The pollution theme assesses the external sources of outdoor air pollution to maintain a good level of air quality. Exposures to outdoor air pollution remain a critical source of health risk to building occupants. Majority of the assessment schemes include innovative aspects into the assessment that can enhance building performance and are encouraged to be adopted. Finally, in order to maintain a building in good condition, it is necessary to assess the quality of service such as reliability and quality of materials, building services and systems.

The importance of managing human well-being and welfare is considered in social dimension. For instance, the welfare of local peoples and communities should be catered. On the other hand, the economic criterion should not be neglected in evaluating the feasibility of the refurbished building in financial terms. The cultural aspect should be integrated into assessment to enhance local cultural value. Lastly, the assessment of heritage value included conservation principles such as reversibility and adaptability that are crucial for heritage buildings.

The process of reviewing revealed several findings. Out of the reviewed assessment schemes, GBC Historic Building is a specific assessment scheme that dedicated for heritage buildings as the existing local assessment schemes in Italy do not assess the heritage value of the heritage buildings [26]. Thus, GBC Historic Building introduces a new assessment theme which is heritage value by considering the intrinsic heritage value of the heritage buildings and also compliance with the conservation principles. However, economic and social dimensions which are part of the sustainability pillars are missing in GBC Historic Building. Three assessment schemes are specified schemes for refurbishment such as BREEAM, CASBEE and GBLS. The remaining assessment schemes are not specific refurbishment assessment schemes, which will adopt either new or existing assessment tools to assess refurbished buildings. However, Boarin [26] criticized that some of existing assessment credits are not suitable for heritage buildings as they are applicable to the construction of new or existing buildings. The assessment of heritage value [26], economic, and social [27] are missing as majority of the assessment schemes allocated major scores on environmental dimensions such as energy and indoor environmental quality as confirmed by Li et al. [8]. Social, economic and heritage dimensions that greatly relate to a building’s performance should consider for assessment. As a result, a comprehensive assessment framework that combines environmental, social, economic and heritage values of heritage building is needed. However, Webb [5] articulated what assessment themes are related to heritage buildings and how these assessment themes should be grouped remain unclear. Hence, the next stage of this research will be conducting Delphi approach with several industry experts in the field to identify the applicable assessment themes for refurbished heritage buildings.

4. Conclusion
Refurbishment offers an alternative solution for demolition to make existing buildings more sustainable for current and future use, in order to satisfy the current standards of energy use and comfort. However, heritage buildings often overlooked in achieving sustainability through refurbishment. Building assessment methods is important in promoting sustainability and govern performance. However, there is a lack of green assessment scheme focuses on refurbishment of heritage buildings. Most of the schemes allocated most of the assessment points in environmental dimension such as energy and indoor environmental quality. The economic, social and heritage dimensions are not covered. Thus, this study intends to develop a refurbishment assessment framework for heritage buildings. A four-stage research method was proposed in this study for developing assessment framework. Stage one is a critical review to identify the relevant assessment themes and sub-themes for heritage buildings refurbishment. It resulted in evaluation of four assessment dimensions (environmental, social, economic and heritage) and fifteen of assessment themes which are related to refurbishment practices. The findings from stage 1 lay a solid foundation for the next step of the research. The next step of the study will be selecting the applicable assessment themes and sub-themes by conducting Delphi approach and then developing a suitable weighting system and classification which suitable for Malaysian geographical environment, by adopting the Analytical Hierarchy Process (AHP). The developed refurbishment framework could be referred by other countries and relevant parties for developing similar refurbishment schemes for heritage buildings which integrate all the important and relevant assessment dimensions especially social, economic and heritage dimensions. This in turn could help in achieving the sustainability goal of the country as stipulated in the United Nation Sustainable Development Goals (UNSDG), specially on the goal of sustainable cities and communities by transforming the way in building and managing the buildings.

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