



PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 22 ISSUE 4 (2024), Page 39 – 55

STRATEGIES FOR NET ZERO CARBON IN SUSTAINABLE CONSERVATION PRACTICES FOR HISTORICAL BUILDINGS IN MALAYSIA

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Abstract

Heritage buildings have always been essential in improving the quality of the city's life, especially for the communities living in historical settings. They play a vital part in representing historical, architectural, cultural, political, spiritual, and symbolic values that are passed down to generations. Historical buildings are often considered dilapidated, and due to society's neglect of these, the historical buildings positioned within the oldest parts of the city have deteriorated. Heritage buildings in Malaysia are defined as historical buildings that are protected under the National Heritage Act 2005 (Act 645) to preserve tangible cultural heritage. This study intends to identify the Strategies contributing to Net Zero Carbon in Sustainable Conservation Practices for Historical Buildings in Malaysia. The research primarily focused on Conservation Architects and Heritage Professionals, with data being collected through semi-structured interviews and subsequently subjected to Thematic Analysis Matrix. The objective was to propose a set of recommendations for sustainable practices in the conservation of heritage buildings in Malaysia, aimed at achieving net zero carbon emissions. This endeavour was aimed at advancing the discourse on Net Zero Carbon in Historical Buildings and fostering public awareness regarding the significance of these architectural treasures.

Keywords: Net Zero Carbon, Sustainable Conservation Practices, Historical Buildings

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INTRODUCTION

Heritage buildings in Malaysia are defined as historical buildings that are protected under the National Heritage Act 2005 (Act 645) to preserve tangible cultural heritage (Mustafa & Abdullah, 2013). The heritage buildings in Kuala Lumpur are supported by the Kuala Lumpur Structure Plan 2020 (KLSP2020) to support comprehensive management of the city, together with Act 107 and Act 72, which provisions the “proper planning in Federal Territory.” KLSP2020 highlighted policies 186 to 190, which clearly concern the heritage building. Policy 189 ensures that all development shall harmonise with the surrounding area to retain the existing character of the city and to enhance the surrounding area. These are the initiatives developed by the Kuala Lumpur City Hall and aim to convert Kuala Lumpur into a city that conserves most of the environment, architecture, and cultural heritage (Kuala Lumpur City Hall, 2004, p.32). Under these circumstances, a less attractive façade could be retrofitted to create a more attractive environment that reflects the character of adjacent heritage buildings in Kuala Lumpur (Kuala Lumpur City Hall, 2008b, p.127).

United Nations Educational Scientific and Cultural Organization (UNESCO) provided its operational guidelines for the implementation of the World Heritage Convention where Clause 163 to Clause 166 mentioned the modification of cultural heritage, which requires the submission of the proposal to undergo Preliminary Assessment for approval, and these only apply to Penang and Melaka Heritage Site and Buildings. Supported by Preliminary Assessment and Annexes, which are the supportive documents written for the procedure of nomination, they are to be approved by the relevant Advisory Bodies. They are based on the views of the professional bodies towards the modification of cultural heritage (United Nations Educational, 2021).

Sarawak Heritage Society (SHS) has provisions for building conservation in Sarawak with the objectives of assisting in the identification of the styles and features of the historical shophouses and areas and identifying the degree or extent of work allowable in any development (PELITA, 1992), while the regulations not listed in Sarawak conservation initiative shall be protected under Malaysia National Heritage Act 2005.

The guidelines provided often focus on the conservation of building appearance and façade (Mat Nayan, 2017). With the provided guidelines, it could be said that the conservation of the external façade within nominal sight appears to be an essential element in maintaining the outlook of heritage or historical buildings. Under the National Heritage Act 2005, there is also no clear assessment in nominating historical buildings as heritage buildings to be conserved or preserved.

RESEARCH BACKGROUND

Due to the issue of global urbanization, city centres have become the primary target for land acquisition, demolition, and rebuilding to maximise economic returns and profits. (Toong & Utaberta, 2015). Moreover, the heritage buildings are under the threat of destruction due to neglect by the owners and demolition due to the city's development, as well as the lack of community concern to conserve heritage buildings (Hanapi, 2021). National Heritage Act 2005 (Act 645) is the replacement of the previous heritage laws and rehabilitation measures to protect heritage properties together with the Local Government Act 1976 (Act 171) and the Town and Country Planning Act 1976 (Act 172) (Yusoff & Dollah, 2013).

However, conflicts arise in defining historical buildings within the Acts, as they automatically attain heritage status once they reach the age of 100 years. Many historical buildings, integral to the identity of a heritage city, have yet to reach this milestone, or even if they have, they often lack protection and are subjected to neglect, leading to their eventual dilapidation and destruction (refer to Figures 1 and 2). Conservation efforts for these historical buildings pose significant challenges, particularly in sourcing replacement materials due to their construction during earlier eras (Zuraidi & Zainal, 2011).



Figures 1 and 2: Dilapidated buildings in Papan, Perak
Source: TSL Media Group, 2021

HERITAGE BUILDINGS ARE NON-ENVIRONMENTALLY SUSTAINABLE TOWARD NET ZERO CARBON IN MALAYSIA

Historical buildings are often characterised by mediocre performance in terms of green building standards (Okba & Embaby, 2013). Therefore, the concept of sustainability becomes pivotal in the conservation and energy efficiency efforts associated with these structures, aiming to extend their lifespan by integrating new functions (BC, 2021). However, interventions aimed at enhancing energy efficiency, particularly during the operational phase, present significant challenges (Kayan et al., 2018). Moreover, the absence of legal frameworks addressing sustainability issues exacerbates conservation challenges in Malaysia.

For instance, the National Heritage Act 2005 primarily focuses on non-sustainable conservation practices for historical buildings, leading to conflicts within national legislation and hindering the environmental sustainability of heritage buildings in the future (Zuraidi & Zainal, 2011). Heritage conservation efforts have traditionally prioritized preserving the physical structures without sufficient consideration for their cultural significance. Consequently, sustaining cultural heritage becomes challenging not only socially but also environmentally, as conservation practices often fail to address broader environmental concerns (Marçal, 2018).

SUSTAINABLE PRACTICES

Net Zero refers to achieving an overall balance between the production and removal of greenhouse gas emissions from the atmosphere (National Grid, 2023). Net Zero Carbon Heritage Building focuses on reducing carbon emissions to the environment and improving energy performance, while sustainability involves increasing and using renewable energy (BC, 2021). This relates to the green approach to historical building rehabilitation and restoration work, which involves the use of greener materials as well as the adoption of green tactics and technologies (Kayan et al., 2018). It is this consideration that helps heritage buildings last longer and accomplish the Paris Agreement goal of becoming a Net Zero Greenhouse Gas Emission Nation by 2050 (Phang, 2021).

Adaptive reuse and retrofit of existing historical buildings are preferable to demolition and reconstruction of new buildings (Aziz, 2020). In theory, historical building upkeep and restoration have an essential role in reducing carbon dioxide emissions in terms of embodied carbon and energy (Kayan et al., 2018). Low-carbon restoration works must go through a comprehensive procedure to determine the low-carbon material from manufacture to transportation and the amount of energy consumed and carbon dioxide emitted. The sustainable practices in Malaysia to achieve Net Zero Carbon have turned out to be an issue since there are no officially published guidelines for buildings across Malaysia.

SUSTAINABLE CONSERVATION PRACTICES FOR NET ZERO CARBON HERITAGE BUILDING

Referring to the National Heritage Act 2005, heritage buildings are mandated to undergo maximum conservation efforts, wherein restoration typically utilizes the same materials as the original structures. However, flexibility exists wherein materials may be substituted with alternatives possessing similar appearances and characteristics. According to Theory 1, sustainable practices in heritage building maintenance and repair are integral to reducing carbon dioxide emissions, particularly in terms of embodied carbon and energy (Kayan et al., 2018).

Approval for the use of new materials in heritage building maintenance is contingent upon conservators' endorsement as per Act 171.

The second theory, proposed by MDPI, advocates for reducing carbon emissions associated with constant maintenance of heritage buildings, especially those less accessible to the public. Utilizing technologies to enhance public access to these structures can mitigate carbon emissions, preserving their original appearance while preventing deterioration of their heritage value and loss of authenticity.

In accordance with Act 645 and city planning guidelines such as KLSP2020, the development of heritage buildings, including the addition of new functions or elements, may be sanctioned, provided that street-level elevations remain consistent with the original structure. Energy-efficient materials integrated into heritage buildings should harmonize with the original building in terms of colour, texture, shape, and scale, albeit being less conspicuous to preserve the building's historical value.

From the literature review, strategies contributing to achieving Net Zero Carbon in sustainable heritage practices can be categorized into three main approaches:

1. Application of Low Carbon Materials in Heritage Building Preservation.
2. Leveraging Digital Technology and Applications to Enhance Access to Heritage Buildings.
3. Implementation of Energy-Efficiency Interventions within Heritage Buildings to Reduce Energy Consumption.

METHODOLOGY

The qualitative research method was employed to fulfil the aims and objectives of this study, which aimed to develop a set of recommendations for sustainable practices in the conservation of Heritage Buildings in Malaysia toward achieving Net Zero Carbon status. Semi-structured interviews were conducted to engage with selected respondents, seeking to comprehend their perspectives on sustainable conservation practices and their perception of Net Zero Carbon Heritage Buildings.

Respondents of the Study

The respondents selected for this semi-structured interview comprise a total of 6 individuals. Among them are 4 conservation architects recognized as conservators, possessing expertise in conservation practice and documentation, along with substantial experience in related conservation endeavours within heritage buildings. Additionally, 2 heritage professionals distinguished for their expertise in Heritage Conservation were invited to partake in this semi-structured

interview. Their participation aims to garner insights into sustainable conservation practices tailored explicitly for heritage buildings in Malaysia.

The scarcity and unavailability of Conservation Architects and Heritage Professionals in Malaysia has meant that this research is justified by the limited number of respondents. This specialized group is important for determining heritage conservation practices; however, there are not enough experts available. This study emphasizes depth rather than breadth based on rich, high-quality insights from a few experts instead of a large less specialized group. The small number of respondents notwithstanding, they have expertise which makes the findings relevant and useful.

Data Collection

The interview questions were written based on the themes and research objectives of this research. The primary purpose of this interview is to examine the current practices in sustainable conservation practices of heritage buildings in Malaysia and to develop a set of recommendations for sustainable practices of conservation of heritage buildings in Malaysia towards net zero carbon. The structure of the questions is formulated to form different categories based on the theories and themes (see Table 1):

- i. Heritage Conservation Practice in Malaysia
- ii. Sustainable Practices
- iii. Sustainable Conservation Practices for Net Zero Carbon Heritage Building

Table 1: Sample set of Questions for Interviews

Literature Review Themes	Interview Questions	Purpose of the Question
HERITAGE CONSERVATION PRACTICE IN MALAYSIA	Materials: 1. What are the sources of materials for the restoration of heritage works in conservation practice? 2. What is the cost of the materials used for restoration compared to local and imported materials or any of the materials had been replaced with local products? 3. Have you figured out the amount of carbon for materials and compared it before the material decision is made? 4. How do you treat the excessive materials left or unwanted materials produced from restoration works?	To identify the sustainable conservation practices that contribute towards Net Zero
SUSTAINABLE PRACTICE	Digital Technologies: 1. What software is used to reconstruct the documentation and material-construction characteristics of a cultural heritage building?	To examine the current practices in sustainable conservation practices

Literature Review Themes	Interview Questions	Purpose of the Question
	2. How do you use AR and VR as the future software for historical buildings? Passive Design Features: 1. What energy-saving façades or fixtures had been installed in heritage buildings? 2. How do you lower the energy consumption of a heritage building? 3. What is the thermal environment in the building?	of Heritage Buildings in Malaysia
NET ZERO CARBON FOOTPRINT HERITAGE BUILDING	Respondents' Opinions: 1. What can also be suggested for sustainable heritage practices for Heritage Buildings in Malaysia?	To identify the sustainable conservation practices that contribute towards Net Zero

Source: Author

Data Analysis

Thematic analysis is mainly used for theory development, where it is used to transform transcripts or collected data into codes (C). The codes were then further developed and categorised into themes (T) (Figure 3). This eventually helped researchers to build general theoretical concepts for qualitative evidence. Findings were interpreted, and implications were discussed in detail in the conclusion (Khokhar et al., 2020). The purpose of this thematic analysis is to uncover relevant themes and patterns in data concerning a phenomenon and to interpret the underlying meaning, implication, and relevance of the built themes with respect to the current body of knowledge (Braun & Clarke, 2006).

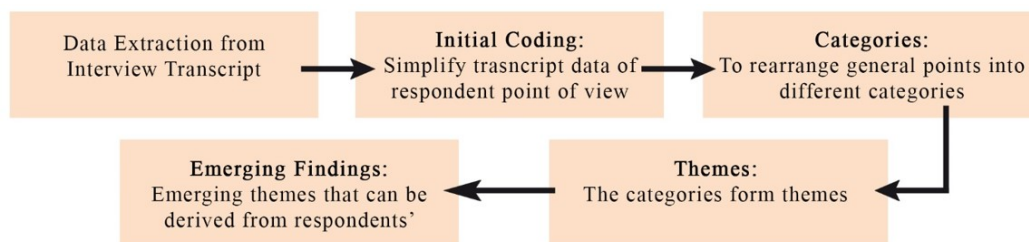


Figure 3: Data Analysis Method

Source: Author

Limitations

Limitations and obstacles encountered during the interview process primarily revolved around the time required to schedule interviews. As a result, the exact number of respondents for data collection through interviews could not be determined. While the aim was to select professionals as respondents to ensure

insightful interviews, the pool of relevant professionals may have been insufficient to provide comprehensive information pertaining to heritage buildings. Additionally, a limitation arose from the fact that respondents' answers might not be entirely accurate, as they were based solely on their experiential knowledge without specific guidelines pertaining to the subject matter. Furthermore, due to the constrained time frame of the interviews, respondents may not have been afforded adequate time to contemplate and justify their responses thoroughly.

DATA ANALYSIS

Replacement of Building Materials

The replacement of building materials involves the utilization of substitute materials that closely resemble the original components, thereby maintaining the visual integrity of the structure. This practice aimed to safeguard the appearance of the building while avoiding the use of materials that deviated significantly from the originals, such as wood or steel. Generally, the adoption of replacement materials resembling the originals, applied or installed in historical and heritage buildings, was viewed positively, especially when the authentic materials for restoration were unavailable or no longer in production. In such scenarios, locally sourced materials bearing a resemblance to the originals, possibly supplemented by imports, were employed to ensure that the restoration process maintained a minimal carbon footprint.

The respondents offered valuable insights into the conservation of heritage and historical buildings, underscoring the significance of preserving their original materials whenever possible. However, in instances where the original materials were untraceable, local substitutes were deemed appropriate alternatives. It remained crucial to uphold the architectural integrity of these buildings to the greatest extent possible, utilizing either authentic materials or suitable replacements that closely mimicked them.

Digital Technology in Sustainable Conservation Practices

Digital technology plays a crucial role in educating and documenting buildings as part of sustainable practices in the conservation of historical or heritage buildings. While traditional methods still prevail in the documentation of historical buildings, experts widely recognize the value of Virtual Reality (VR) and Augmented Reality (AR) in this field. These technologies not only enable access to hardly reachable historical buildings but also allow for the documentation of buildings at various stages, preserving their originality without being susceptible to weather or natural disasters. This approach contributes to sustainable conservation practices by maintaining the overall appearance of

historical or heritage buildings with fixed data, which can serve as educational resources for future generations regarding current building facades.

Energy Efficiency Methods

The elevation and façade of the building must be maintained during conservation works. Experts concur on the installation of passive design features, primarily due to changes in the building's function, which may involve adaptive reuse rather than strictly adhering to sustainable conservation practices. Nevertheless, given prevailing weather conditions, minor passive design features may be incorporated into historical buildings, provided that the original appearance of the building's elevation is preserved to adapt to current weather conditions while maintaining its original function.

Experts recognize that the conservation of cultural heritage involves actions aimed at prolonging the life of cultural heritage while preserving heritage values. Consequently, changes in building functions represent an approach to extending the lifespan of historical buildings.

Summary of Analysis

The semi-structured interview was conducted with experts to support the qualitative research method employed in this dissertation. The interview questions were structured based on the initial theoretical framework developed through a review of relevant literature in the field. Throughout the analysis process, data was initially extracted and categorized using the thematic analysis method. The categories were established based on the initial coding derived from following the steps outlined in the thematic analysis. The final overarching themes were then generated and cross-checked with responses from various experts.

Additionally, sub-themes were identified based on the expert responses. The findings from the interviews yielded 20 categories, which were subsequently grouped into 10 main themes: Renewable materials for historical buildings (T1), Original materials for restoration works (T2), Materials replacement while preserving building aesthetics (T3), Low carbon content building materials (T4), Historical influences on building material selection (T6), Integration of digital technology in conservation efforts (T7), Utilization of digital technology in educational contexts (T8), Manual conservation practices and their limitations (T9), Implementation of mechanical ventilation in historical buildings (T11), and Strategies for carbon reduction in historical buildings (T12). Sub-themes were also identified, including Building function's impact on façade and aesthetics (T5) and Building function's influence on building lifespan (T10) (see Figure 4).

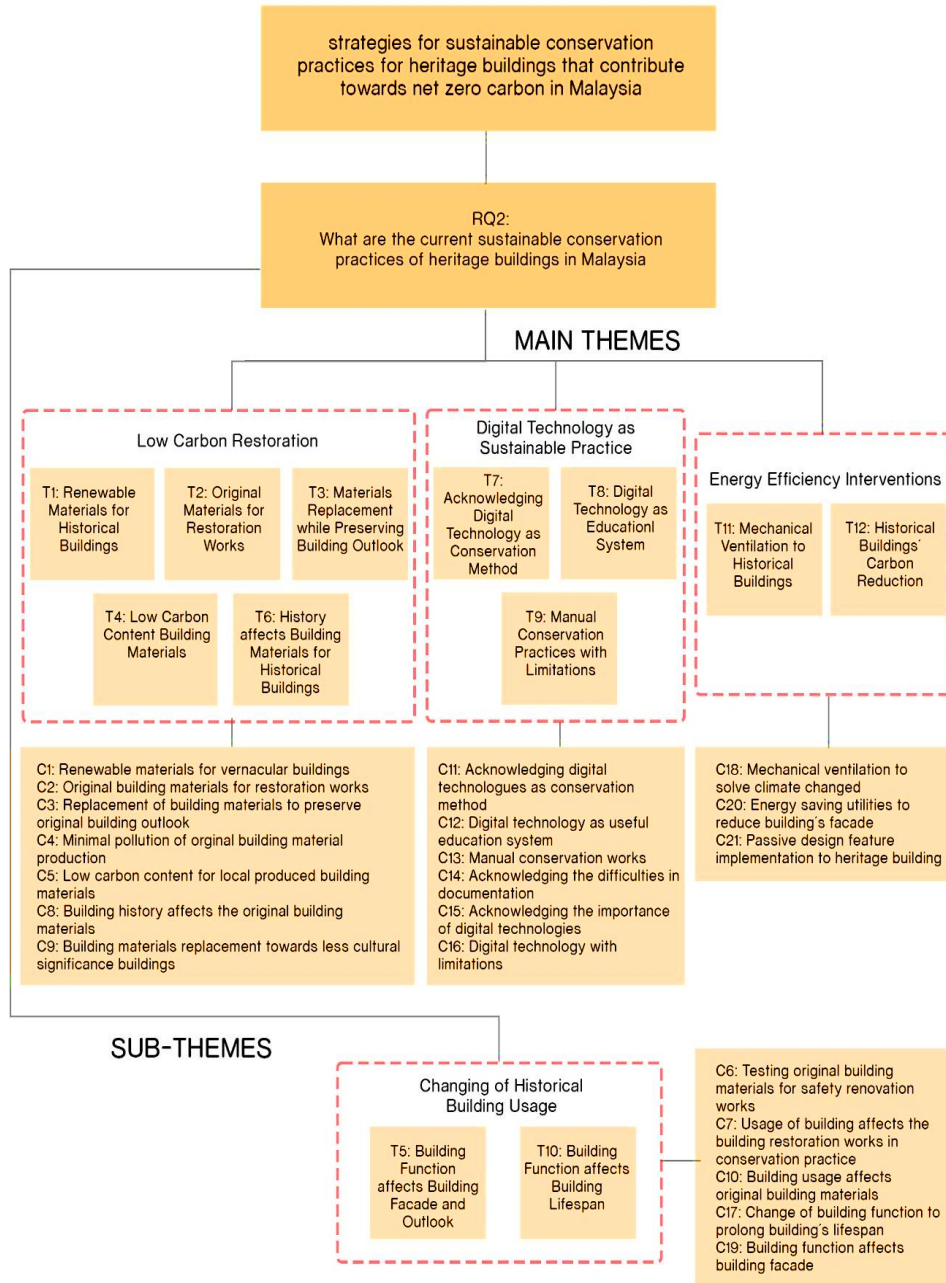


Figure 4: Summary of Analysis
 Source: Author

FINDINGS & DISCUSSIONS

Low Carbon Restoration

Low carbon restoration practices are applicable to various historical and heritage buildings, particularly local vernacular heritage structures, as these buildings typically utilize locally sourced materials whose production can be tracked for availability. Restoration efforts for vernacular architecture inherently involve the use of low-carbon materials, often renewable or locally available materials that negate the need for imports. Colonial buildings, characterized by a fusion of Eastern and Western architectural influences adapted to regional climates (Kuncoro et al., 2022), were historically constructed using imported materials due to their location in port areas.

In conservation practices, the restoration of colonial buildings typically necessitates the use of imported materials to preserve the originality and visual integrity of the structures. However, in cases where imported materials are no longer produced or available in the market, replacement materials may be utilized for restoration, provided that they maintain the building's original appearance and façade. This approach aims to preserve the authenticity of colonial buildings while ensuring the continuity of their historical significance.

Historically, heritage buildings often served as office spaces but may now be repurposed as museums or archival centers for public visitation. Ensuring visitor safety is paramount, and modern conservation practices must address this concern. Changes in building function should be accompanied by adjustments in building materials to enhance user-friendliness while preserving the overall appearance and heritage value of the structure.

Prioritizing the identification of each heritage building's cultural significance is crucial, particularly for Class 1 heritage buildings, where original material restoration takes precedence. For structures with lesser cultural significance, locally sourced materials resembling the original appearance may suffice for restoration purposes. Consequently, low-carbon restoration techniques can be feasibly implemented in certain heritage buildings across Malaysia, facilitating sustainable conservation practices.

Digital Technologies as Sustainable Practices

Digital technologies encompass more than just modern documentation methods; they also encompass Virtual Reality (VR) or Augmented Reality (AR), providing visitors with immersive virtual experiences. Additionally, digital documentation involves utilizing modern tools such as digital measuring devices and computer software to create digital models of heritage sites, which serve as valuable research tools (Koszewski et al., 2021). These technologies have the potential to contribute to sustainable conservation practices for heritage buildings in Malaysia, aiding in the pursuit of Net Zero Carbon emissions.

While experts recognize the availability of digital technologies, their adoption, particularly of digital documentation and visualization tools, remains relatively low among conservators in Malaysia. Manual documentation techniques persist as the preferred method for recording heritage buildings in conservation efforts. However, Virtual Reality offers a promising avenue for providing users with immersive experiences of inaccessible heritage sites, potentially reducing carbon emissions associated with traditional documentation methods.

Despite its advantages, digital technology has limitations, particularly in replicating physical sensations realistically. Nonetheless, it serves as an educational tool, enlightening the public about inaccessible heritage sites and facilitating remote researchers' access to digital representations of these sites.

Energy Efficiency Interventions

The energy performance of heritage buildings is intrinsically linked to the prevailing climate conditions of their respective locations. As climate change leads to gradual temperature increases, the performance of these buildings has suffered, resulting in suboptimal indoor climate conditions and discomfort for prolonged occupancy (Huerto-Cardenas et al., 2021).

According to experts, energy efficiency interventions extend beyond merely enhancing the façades of historical or heritage buildings. They also encompass the installation of Heating, Ventilation, and Air Conditioning (HVAC) systems to improve indoor air quality while bolstering energy performance, with the goal of transforming heritage buildings into Net Zero Carbon structures.

Experts concur that passive design features, serving as energy efficiency interventions, could be integrated into the conservation of historical or heritage buildings. However, such interventions are contingent upon changes in building function; altering the façade may contravene conservation principles. Mechanical ventilation emerges as a crucial intervention to address climate change, as traditional façade designs may not adequately accommodate current climatic conditions.

In instances where heritage buildings undergo significant functional changes to accommodate increased occupancy, retrofitting the building façade and HVAC system becomes essential to align with the new building function while preserving its historical integrity.

Change of Historical Building Usage

This strategy aims to prevent the abandonment of certain historical buildings while simultaneously preserving their intrinsic value and engaging the public. It constitutes a sub-strategy involving the alteration of the usage of historical

buildings, a concept known as adaptive reuse. Adaptive reuse entails repurposing old buildings to serve new functions as a conservation strategy for cultural heritage, allowing these structures to adapt to current climate conditions and urban development (Plevoets & Van-Cleempoel, 2011).

The previously installed building materials in heritage buildings were typically sustainable for their original functions. However, heritage building sustainability extends beyond merely maintaining the physical structure; it also involves ensuring long-term usability for occupants and preserving the cultural value within the urban fabric. One effective strategy to sustain these buildings is to convert their original functions, such as transitioning from office spaces to commercial establishments that generate income to cover restoration expenses in conservation practices.

It can be argued that due to their age and deterioration, historical and heritage buildings may not be sustainable over extended periods for their original purposes. Safety concerns often arise, rendering continued use impractical. According to experts, a viable approach to prolonging the lifespan of such buildings involves adapting their original functions. This adaptation not only allows the building to endure for a more extended period but also prevents its abandonment and eventual removal from the urban landscape.

Recommendation of Sustainable Practices of Conservation of Heritage Buildings in Malaysia towards Net Zero Carbon

There are recommendations concluded from this research based on the theories and current conservation practices that shall be used for sustainable conservation practices of Heritage Buildings in Malaysia towards Net Zero Carbon:

A. Building Materials & Restoration

1. Similar renewable resources should replace renewable building materials,
2. The replacement of building materials is permissible only in cases where the original materials are no longer in production.
3. Replacement of building materials may apply to heritage buildings with less cultural significance value.

B. Digital Technology and Documentation

4. Digital measurement tools in documentation practices,
5. Digital documentation works for sustainable conservation practices and
6. Virtual Reality and Augmented Reality are future assets that will preserve historical or heritage buildings with high cultural significance.

C. Energy Efficiency Interventions and Building Façade

7. Mechanical ventilation to improve indoor air quality,
8. Changing the façade or addition to the building shall depend on the building function for heritage buildings and
9. Energy-saving utilities and passive design interventions could be installed for operating heritage buildings.

D. Building Function and Usage (Optional Sustainable Conservation Practices)

10. Adaptive Reuse of Heritage Buildings to preserve the Heritage Assets and Value.

CONCLUSION

The study of conservation practices for heritage buildings contributing to achieving net zero carbon emissions in Malaysia has yielded a set of strategies for sustainable conservation practices. These practices aim to facilitate the development of net-zero carbon heritage buildings in Malaysia.

Sustainable conservation practices conducive to achieving net-zero carbon emissions were identified through a literature review, which provided theoretical frameworks categorized into three main theories. These theories were translated into research questions, and semi-structured interviews were conducted to investigate current practices in the sustainable conservation of heritage buildings in Malaysia. The purpose of these interviews was to validate the theories derived from the literature, recognizing that theoretical frameworks may not always align with practical applications in the context of Malaysia's heritage building conservation practices.

Through the analysis of findings and discussions, a set of recommendations for sustainable conservation practices in Malaysia aimed at achieving net zero carbon emissions has been developed. These recommendations serve as a simple guideline for architects and conservators involved in future sustainable conservation projects for heritage buildings. The primary implication of this research lies in the preservation of heritage buildings and their cultural significance, along with the necessity of extending their lifespan.

Amidst current climate conditions and urban pressures, heritage buildings may face abandonment due to their perceived lack of relevance compared to contemporary city development. This neglect could ultimately result in their demolition to make way for future construction projects. The significance of this research extends beyond merely safeguarding heritage buildings against climate change; it also aims to ensure their longevity within urban settings while preserving their cultural heritage and intrinsic value.

Whether through adaptive reuse or the alteration of building functions to enhance their appeal, these efforts facilitate public access to and understanding of the significance of historical or heritage buildings as integral assets within the urban fabric. Such initiatives reinforce the importance of these buildings' presence and their cultural value, thereby contributing to the creation of vibrant cities enriched with cultural heritage.

The recommendations outlined provide a framework for conducting more targeted research on sustainable conservation practices and their implications in Malaysia. Further investigation by scholars is essential to promote the adoption of sustainable conservation practices by conservators and architects in Malaysia, ultimately leading to the realization of net-zero carbon heritage buildings.

DISCLOSURE STATEMENT / ETHICAL STATEMENT

This is original research by the authors. It includes the work and complete research on the topic: Strategies Contributing to Net Zero Carbon in Sustainable Conservation Practice for Historical Buildings in Malaysia.

This research was conducted based on references from government bodies and other professionals on heritage buildings and sustainable building studies. This research focuses on the contribution of historical buildings towards net zero carbon in Malaysia, which is partly responsible for the environmental issues arising in the world.

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Received: 22nd Mar 2024. Accepted: 8th July 2024