

Integrating Heritage and Sustainability: A Stakeholder Experience in Implementing the Green Building Index (GBI) for Historical Buildings Towards Sustainable Cities

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ABSTRACT

The increasing emphasis on sustainable development has led to the integration of green certification systems such as the Green Building Index (GBI) in Malaysia's construction sector. However, the application of GBI in historic building projects presents unique challenges due to the inherent conflict between conservation principles and contemporary sustainability standards. The primary aim of this research is to examine the deficiencies of existing practices, and the issues and challenges associated with the application of the Green Building Index for historical buildings in Malaysia. An interview framework was established by selecting experts and stakeholders from the conservation industry for a session that included a Heritage Conservator and a B03 contractor Project Manager. Interviews were undertaken to gather individuals' thoughts and experiences regarding sustainable practices in heritage conservation initiatives. The findings shows that the challenges mostly stem from concerns related to the predominant emerging themes are: (C1) Regulatory and Principles Constraints; (C2) Technical and Design Constraints; (C3) Lack of Stakeholder Awareness, recorded five times; (C5) Resistance to Change by Stakeholders; (C6) High Initial Cost, recorded three times; and finally, (C4) Lack of Incentives, recorded two times. Thus, there is an urgent necessity for interdisciplinary collaboration in the creation of heritage-sensitive green technologies that honour sustainability objectives and conservation ethics, alongside integrated governance models that foster synergy rather than discord between conservation and sustainability.

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1. INTRODUCTION

In light of Malaysia's development status, most of the building stock was in ascendancy to the extant building (Mohd Hanapiah et al., 2022). The aggregate performance of Malaysia's property stock of existing buildings was approximately 6.67 million units in 2019, as indicated by the Valuation and Property Services Department Malaysia (NAPIC, JPPH, 2020). The national objective of achieving Near Zero Energy Buildings by 2040 will be jeopardised by the substantial number of extant buildings that have not implemented sustainable building design and principles. The current unsustainable building is responsible for consuming 40% of the world's energy production. Nevertheless, residential and commercial structures in Malaysia consume approximately 15% of the energy, a figure that is increasing over time Mohd Hanapiah et al., (2022). Consequently, they also added that the implementation of green retrofitting measures in Malaysia, which are characterised by a high density of existing structures, will contribute to at least 80% of the potential national emission target and is a viable solution to mitigate the environmental impact rather than relying solely on new sustainable development initiatives.

Nevertheless, integrating GBI notions into historic building projects is challenging. These structures, often protected for their cultural, architectural, and historical significance, require sensitive conservation measures that may not match historical sustainability indicators. This research investigates the primary challenges when employing GBI guidelines for heritage building conservation. This topic is significant in light of the growing interest in merging environmental sustainability and heritage preservation, which often involves technical, legislative, and philosophical challenges. Heritage conservation prioritises authenticity, material integrity, and historical context, which may be undermined by invasive retrofitting or strict compliance requirements, while sustainability frameworks including GBI mitigate environmental consequences (Alaudin et al., 2022). These challenges are identified in this analysis to inform policy development and interdisciplinary collaboration between conservation and sustainability experts. The result would help Malaysian historical buildings go green (Alaudin et al., 2022). Apparently, to improve building efficiency and provide a healthy living and working environment, green approaches and technology can be used. Ultimately, multiple adaptive reuse projects in the US have received US Green Building Council LEED Platinum, meeting the highest sustainability standards. However, the primary concern is that Malaysian Non-Residential Existing Buildings (NREB): Historical Buildings have not adopted the GBI. According to Mohd Hanapiah et al. (2022), the Green Building Index (GBI) Malaysia Executive Report as of 30 June 2023 shows 32 certified Non-Residential Existing Buildings (NREB) and four implementations, totalling 5%. This indicates a large green building implementation gap between existing and new buildings. It's because 336 Non-Residential New Construction (NRNC) and 229 Residential New Construction (RNC) were certified, totalling 86%. The International Energy Agency (IEA) reported in 2019 that existing buildings Masrom et al., (2017) and construction sectors consume 36% of energy and produce 39% of CO₂ emissions.

2. LITERATURE REVIEW

2.1 An Overview of Heritage Building

Heritage is historical or culturally significant things or customs that can be passed down or inherited. Historic structures are tangible assets with national, regional, municipal, religious, or symbolic value. Historical buildings include shophouses, administrative buildings, dwellings, and churches. Apparently, heritage buildings showcase Malaysia's most fascinating history and culture. Heritage buildings with architectural and historical significance can be discovered around the nation. Malaysia's heritage structures reflect its rich architectural past, which blends Islamic, Chinese, and Western elements, according to Bahauddin et al. (2010) and Harun (2011). They also noted that Malaysia's nearly three centuries of colonial rule are shown by the prevalence of Portuguese, Dutch, and British colonial architectural styles. These distinctive heritage buildings are in all major cities and helped develop the country's heritage cities. These constructions are found in railway stations, mosques, jails, schools, palaces, traditional Malay dwellings, Hindu temples, Chinese storehouses, churches, clock towers, institutional buildings, and monuments. These structures have varied artistic origins. Moorish (Old General Post Office, 1894), Tudor (Royal Selangor Club, 1884), Neo-classical (George Town Municipal Council Building, 1879), and Neo-gothic (Carcosa house, 1897) were these. Culture, heritage, and cultural heritage are the "complex whole that includes knowledge, beliefs, arts, morals, laws, and any other capabilities and habits" in a society, according to UNESCO (Suaib et al., 2020).

2.2 Green Building Index Key Criteria Features

Despite regional terminologies like "Sustainable Building," "Eco-Friendly Building," "Green Building," "Energy Efficiency Building," and "Net Zero Energy Building," the ultimate goal is to improve building operational efficiency while conserving the environment. Apparently, a "green building" reduces environmental consequences while improving residents' comfort and finances. Thus, integrating sustainability concepts into new development design and maintaining sustainable practises throughout the building's life, especially for heritage building conservation, can achieve the goal (Wong et al., 2021). Energy efficiency, interior environmental quality, sustainable site planning and management, material and resource efficiency, and water efficiency are the main factors in green adaptive reuse of historical buildings (Alaudin et al., 2022). Table 1 shows a description of GBI NREB Historic Tools.

Table 1. A description of GBI NREB Historic Tools

Key Criteria Features	Description based on NREB Historic Tools
Energy Efficiency (EE)	Historic building energy efficiency is its operating energy, according to Asman et al. (2019). According to Asman et al. (2019), passive heating and cooling and building envelope insulation save energy by reducing heat transfer. Most French buildings are greener by replacing windows with double-glazed ones, updating insulation, and correcting HVAC

	systems (Shahi et al., 2020). Increasing a building's energy efficiency reduces carbon dioxide emissions (Calise et al., 2020).
Indoor Environmental Quality	IEQ encompasses IAQ, thermal comfort, lighting, visual, and auditory comfort. For full preservation of historic structures and acceptable indoor conditions, Alaudin et al. (2022) suggest that thermal comfort is vital. To evaluate historical building adaptive reuse, fully naturally ventilated spaces, mechanical ventilation and air conditioning systems, automated indoor temperature regulation, and moisture and humidity control were identified (Alaudin et al., 2022). Architectural adaptive reuse requires indoor air quality, thermal comfort, lighting, and visual comfort (Marzouk et al., 2020; Shahi et al., 2020; Asman, 2019). Example: lighting lux levels. Penaga Hotel, Penang (Ismail et al., 2016), and Colonial Shophouses, Kuala Lumpur (Alaudin et al., 2022), use LED lights to save energy and increase lighting efficiency. Window tinting and curtains were used to improve natural illumination and visual comfort. Building residents get ideal sunshine and views from the large window openings (Kilian et al., 2018; Marzouk, 2021; Mehr, 2018). The adaptive reuse of historic buildings relies on acoustic comfort to improve user experience (Khalil et al., 2021; D'Orazio, 2020). D'Orazio et al. (2020) claim that historical buildings can only achieve acoustic pleasure by managing individual noise. Acoustic materials like polyester and hybrid jute-polyester composites reduce noise and sound impacts in structures due to their high density and sound insulation (Mehr & Wilkinson, S., 2018; Aly et al., 2021).
Sustainable Conservation and Management	Facility management inspections encompass condition assessments and detailed evaluations. Building structural integrity, roof, windows, HVAC, plumbing, and utility systems are evaluated during the facility evaluation (Miraj et al., 2021). Chew et al. (2017) define green facility management as waste minimisation, energy management, and utility reduction throughout the building's life cycle. Renewable energy sources including biomass wood pellets, geothermal heating, solar thermal heating, and absorption cooling should heat and cool the green building (Alaudin et al., 2022).
Material and Resources	Reuse historic architectural goods and materials to reduce waste and demand for virgin resources while preserving their cultural, social, and historical significance. This reduces the environmental impact of raw material mining and processing. Recycling and reusing theories for sustainable rebuilding appear to benefit the environment (Tam & Hao, 2019; Mak et al., 2019). Apparently, reusing historical structures extends their lifespan and reduces construction material use (Sharifi & Farahinia, 2020; Lu et al., 2019). Meanwhile, steel recycling reduces environmental effect mostly through reuse (Sanchez et al., 2019). Blab al discovered that 70% of 2,500 bricks could be reused and the rest recycled (De Gregorio et al., 2020). Recycling materials and reusing structural components helps reduce landfill building waste (Sharifi & Farahinia, 2020). Landfills can also reduce greenhouse gas emissions (Tam & Hao, 2019).
Water Efficiency	Sustainable architecture relies on water conservation (Huo et al., 2017). Water efficiency in historical structures must be improved by using materials and practices that reduce water usage. Since buildings' water and wastewater systems are energy-dependent, water

	efficiency affects their economic performance (Asman et al., 2019). Thus, improving water efficiency reduces treatment waste, promoting environmental sustainability (Luthy et al., 2020). Conserving and using water appropriately saves energy and reduces greenhouse gas emissions (Chhipi-Shrestha et al., 2017). Thus, water efficiency highlights the 5Rs: reduction of consumption, minimisation of loss and waste, re-use, recycling, and alternative sources (Asman et al., 2019).
Innovation	The Innovation (IN) criterion in the GBI Malaysia is designed to encourage and reward projects that implement new, creative, or pioneering sustainability strategies, designs, or technologies that go beyond the standard GBI requirements. It recognizes exceptional efforts to push the boundaries of green building practices in ways that improve environmental performance, occupant well-being, or overall project sustainability.

Source: Authors

2.3 The Importance of Green Initiative for Heritage Building Conservation Towards Sustainable City Planning

Malaysia's historic cities have several heritage buildings. Azmi et al. (2015) claim that the Heritage Trust of Malaysia's 1992–1993 inventory evaluation found almost 39,000 historic buildings built between 1800 and 1948 that need preservation and conservation. These were 'pre-war buildings,' built between 1800 and 1948. Historic cities including George Town, Ipoh, Malacca, Taiping, Kuala Lumpur, and Kuching have such constructions (Azmi et al., 2015; Sodangi, 2013). Based on the aforementioned, Jabatan Warisan Negara has designated 183 buildings as heritage buildings (Ali et al., 2018). A potential heritage building needs to fulfil several criteria to be designated a national heritage property, including historical importance, association with or relationship to Malaysian history, good design or aesthetic characteristics, scientific or technical innovation or achievements, social or cultural associations, and the potential to educate, illustrate, or provide further scientific research on Malaysian cultural heritage. Apparently, potential heritage sites, structures, or things that meet national heritage classification requirements are more likely to be conserved (Baharuddin et al., 2022; Harun, 2011; Jabatan Warisan Negara, 2017). Conservation of historic structures began in the 1970s with the Second Malaysian Plan (Said et al., 2018). The National Heritage Act 2005 established a comprehensive legal framework to control heritage building matters countrywide, followed by increased heritage awareness spending in Ninth Malaysia (Baharuddin et al., 2022). Heritage building conservation also involves restoration, preservation, rebuilding, rehabilitation, and adaptation, or any combination of these (Harun, 2011). Meanwhile, Mohd Hanapiah et al. (2022) and Alaudin et al. (2022) define rehabilitation, refurbishment, and retrofitting differently. Table 2 shows the characteristics identified through definition by legal frameworks at national level.

In this vein, Baharuddin et al. (2022), Section 40 (Application for Planning Permission for Heritage Site) of the National Heritage Act 2005 (Act 645) requires the National Heritage Department (NHD) to approve all heritage site applications before project start-up. Thus, JWN will ask the authorised physical conservator to work with the contractor and client to preserve Heritage City's heritage building. Heritage building conservation initiatives are generally located in older urban districts and nearby towns for easy access to

transport and markets (Alaudin et al., 2022; Halim and Thambi., 2021). Greater urban density is not always negative when compared to other options. Apparently, linking conservation concepts with a sustainable agenda facilitates the integration of new urban design that harmonises historical buildings with present constructions for environmental sustainability. Reusing building stocks may enhance adaptation designs by adding character and establishing historical connections that attract visitors and tourists. The amalgamation of antiquity and modernity may be particularly attractive (Alaudin et al., 2022). Nevertheless, the majority are not regarded as exemplary instances of environmental design. This method possesses significant potential as it integrates environmental considerations into local and regional planning and Sustainable Development Goals (SDGs) No. 11. Under Sustainable Cities and Communities, the strategic focus is believed to enhance inclusiveness towards an equitable society and improve well-being as shown in Fig. 1.

Table 2. The characteristics identified through definition by legal frameworks at national level

Conservation terms	Description
Refurbishment	A process of reinstating a building's or system's original condition, while mitigating the effects of physical obsolescence. Typically implemented on historical and heritage structures to preserve the architectural integrity and historical significance.
Renovation	A process of enhancing refurbishment through the integration of enhancements to the building's physical characteristics. It can be utilised for any intended extension, modification of functioning, and healing of structural fractures.
Retrofitting	The process of replacing and enhancing systems and technologies in existing buildings to rectify technological or environmental obsolescence. Advantageously implement strategies in buildings that possess the potential to enhance performance through sustainable elements.

Source: Authors

11 SUSTAINABLE CITIES AND COMMUNITIES  Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable 10 15 TARGETS INDICATORS	
Target	Indicator
Target 11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage	Indicator 11.4.1: Total expenditure (public and private) per capita spent on the preservation, protection and conservation of all cultural and natural heritage, by type of heritage (cultural, natural, mixed and World Heritage Centre designation), level of government (national, regional and local/municipal), type of expenditure (operating expenditure/ investment) and type of private funding (donations in kind, private non-profit sector and sponsorship)

Fig 1. SDG's Goal No. 11

Source: Authors

3. RESEARCH METHODOLOGY

The primary aim of this research is to examine the deficiencies of existing practices, and the issues and challenges associated with the application of the Green Building Index for historical buildings in Malaysia Ipoh Town Hall and Old Post Office Building (ITH-OPO). An interview framework was established by selecting experts and stakeholders from the conservation industry for a session that included a Heritage Conservator and a B03 Contractor Project Manager, both of whom possess experience in managing heritage conservation projects that adhere to the green building index, specifically targeting Non-Residential Existing Buildings (NREB). The interviews were selected as the primary data collection method due to its efficacy in elucidating aspects that cannot be directly witnessed. Interviews were undertaken to gather individuals' thoughts and experiences regarding sustainable practices in heritage conservation initiatives. While the interviewer possesses a list of topics to address, they are permitted to modify the phrasing and order of the enquiries. The interviewer concentrated on the subsequent overarching themes:

- Understanding Green Building Index
- Challenges with the adoption of six principal criteria for the implementation of historical buildings.

The heritage conservator (R1) and project manager (R2) were interviewed over a month. Interviewees were chosen for their tacit and explicit knowledge of green building index implementation in historical structures to strengthen the study. Selective sampling selected representatives from the regional historical city's historic conservation initiative to participate in the study. The interview was done exclusively online via Google Meet. The textual data was analysed using thematic analysis. Data themes are identified, analysed, and reported using thematic analysis (Mohamad, 2021; Braun & Clarke, 2006). As the study and report expand, the coding can be updated and merged to identify conflicts and contradictions. This approach identified the predominant green building index themes for historical construction (Alaudin et al., 2022).

4. RESULT AND DISCUSSION

Two primary transcript analyses were conducted based on the interview sessions conducted. The studies encompassed demographic data of the participants, comprehension of the definitions of the Green Building Index and historical buildings, and the recognition of challenges encountered during the application of the six criteria in the GBI for Non-Residential Existing Buildings (NREB) during commencement of Ipoh Town Hall and Old Post Office Building (ITH-OPO) project is illustrated in Table 3. This investigation offers critical insights into the obstacles encountered in the conservation sector regarding the documentation and collecting of data throughout the whole conservation process, including the maintenance phase of heritage structures.

Table 3. Demographic Information of Respondent

Code	Position	Years of experience
R1	Registered Conservator / Consultant - (Heritage Conservation Project)	10 years
R2	Project Manager (B03 Contractor) – (Heritage Conservation Project)	12 years

Source: Authors

As a result, Table 4 identifies six significant challenges associated with the implementation of GBI in historical buildings are as follows:

Table 4. Issues and Challenges Green Building Index implementation for Historical Building

Item	Respondent's Responses
EE	<u>R1</u> - “From a conservation perspective, the biggest challenge is reconciling preservation principles and regulation (C1) with performance-driven interventions. One of the most pressing issues under EE is the incompatibility between modern energy-efficient systems and the technical constraints of historic structures (C2). Most of heritage buildings were not designed with ducting or wiring in mind, so retrofitting them with HVAC systems or LED lighting involves invasive interventions (C1). These modifications often clash with the conservation principle of minimum intervention, potentially damaging heritage materials (C1) like timber joists or lime-plastered walls. From an architectural standpoint, there’s a fine line between enhancing energy performance and preserving historical integrity. In addition, high initial cost (C6) as well as the lack of specific financial incentives or grant schemes (C4) for green-certified heritage projects amplifies this hesitation.” <u>R2</u> – “Starting with EE, the most significant constraint is that historic buildings were never designed to technically accommodate modern HVAC, insulation, or lighting systems (C2). Walls are usually solid masonry with no cavity for insulation; windows are typically single-glazed and timber-framed. Thus, introducing double-glazing or external insulation may damage façades or compromise heritage significance (C1). Also, installing high-efficiency air-conditioning systems often requires major mechanical interventions—ducting, piping, electrical work—which can’t be concealed without affecting

	ceiling roses, timber beams, or decorative plasterwork. Moreover, it was pointed that financial apprehensions among building owners and developers, who often perceive GBI certification as a costly (C6) , bureaucratic process with uncertain returns.”
IEQ	R1 – “Similarly, for IEQ, GBI standards often emphasize thermal comfort through mechanical systems. Yet, many heritage buildings were designed with passive cooling strategies—such as high ceilings, thick walls, and cross ventilation—which are environmentally effective but undervalued by GBI scoring (C1).” R2 – “Additionally, the core aspects of IEQ are ensuring thermal comfort, adequate ventilation, and good air quality. But most heritage buildings in Malaysia were designed for natural ventilation (C2). You’ll find features like high ceilings, large operable windows, deep overhangs, and internal courtyards—all of which provide excellent passive cooling and daylighting. Ironically, while these are naturally sustainable, the GBI tool tends to favor mechanical systems—like air conditioning with zoning control, mechanical ventilation, or high-efficiency air filtration—to achieve the IEQ points. It becomes difficult to score in IEQ unless supported by extensive simulation data or performance testing, which isn’t always feasible on older buildings (C2).”
SCM	R1 – “However, we encounter significant technical and architectural limitations (C1) that complicate this ideal. Firstly, conservation requires a delicate balance between preserving authenticity and introducing upgrades. For example, GBI encourages comprehensive documentation and adherence to best practices, but many older buildings lack original construction drawings or formal records (C2, C3), which hinders proper documentation at the level GBI expects. Installing modern systems requires routing through solid masonry or timber structures, posing risks to structural integrity and aesthetic coherence (C1). The building fabric simply wasn’t designed to accommodate contemporary mechanical or electrical systems.” R2 – “From a project management perspective, it’s also about cost and uncertainty (C6) as well reluctant to adopt with a new framework (C5). Retrofitting for SCM in a heritage context often leads to scope creep. Once you start intervention, you uncover unforeseen issues—termite damage, brittle wiring, moisture retention. Every technical decision has architectural implications, and vice versa (C2). The GBI SCM criteria push us towards ‘proper and complete’ documentation and ‘best practice’ interventions, it assumes access to skilled conservators and artisans, which are scarce and expensive (C2).”
MR	R1 – “This is a very important area because the MR criterion is closely aligned with the essence of heritage conservation. It promotes reuse of historic building fabric, preservation of traditional craftsmanship, and reduction of environmental impact through material efficiency. However, in practical terms, we often face significant technical constraints (C1), when trying to align this with GBI scoring. Firstly, original materials in historic buildings are often difficult to document in terms of embodied energy, life cycle cost, or carbon content (C2), because they were never subjected to the kinds of environmental product declarations that GBI typically looks for. For example, try proving the embodied energy of century-old timber joists or clay bricks—it’s not straightforward.” R2 – “From a technical perspective, heritage buildings present retrofitting limitations (C2) that we don’t typically see in modern structures. For instance, under the MR category, GBI prioritizes the use

of certified green products or recycled content. But heritage conservation **often involves the reuse of original materials—like reclaimed bricks or lime-based finishes—that don’t have environmental certifications (C2)** even though they are inherently sustainable. Moreover, **there is a serious shortage of trained craftsmen in traditional Malaysian building techniques (C3)**—be it lime plastering, intricate wood carving, or handmade roofing. Even if we can find them, their services are **specialized and costly (C6)**, and project budgets—especially for public buildings—don’t always support such commitment.

Also, current GBI tools do not fully quantify or reward the **social and cultural impact of employing traditional craftspeople (C4)**. There’s **lack of awareness where there is no direct score for preserving craft heritage through skill transmission (C3)**, which is unfortunate because it’s a crucial part of sustainable conservation.”

WE **R1** – “WE are another area with difficulty. Many historic buildings **use traditional rainwater harvesting methods or don’t have plumbing systems that support modern fittings (C3, C5)**. Installing low-flow fixtures often requires **major retrofitting that can disturb historic finishes or walls (C1)**.”

R2 – “When it comes to, WE, another critical criterion, **historic buildings often lack stakeholder’s awareness regarding the infrastructure needed to support new plumbing layouts (C2, C3)** or efficient fixtures. Upgrading these systems without damaging walls, beams, or floors is often impractical. Similarly, **roof rainwater harvesting systems may require additional weight or structural changes (C2)** that the original building cannot support.”

IN **R1** – “In terms of innovation, heritage projects have a lot to offer. Integrating **an awareness about traditional craftsmanship with modern sustainability thinking should be rewarded (C3)**. For example, reusing original building components or adapting passive features like wind towers or timber louvres can be both sustainable and culturally respectful—but the GBI system needs to offer more flexibility to recognize such innovations.”

R2 – “However, I believe that heritage buildings can lead innovation. If we broaden the scope of what GBI defines as **‘innovation’ and willing to change among the stakeholders (5)**, we can include **passive cooling techniques, traditional ventilation, or the integration of vernacular design** with low-tech solutions. But again, this needs more interpretive flexibility from the GBI rating body.”

Legends:

(C1) Regulatory and Principles Constraint

(C2) Technical & Design Constraints

(C3) Lack of Stakeholder Awareness

(C4) Lack of Incentives

(C5) Resistance to change by Stakeholders

(C6) High initial cost

Source: Authors

Fig. 2 highlights the challenges associated with the implementation of GBI in historical buildings.

<i>Challenges</i>	<i>Mechanism</i>	<i>Impact</i>
(C1) Regulatory and Principles Constraint	Integrating Heritage and Sustainability	Towards Sustainability Cities as outlined in Sustainable Development Goals (SDG No. 11) & Section 40, National Heritage Act 2005
(C2) Technical & Design Constraints		
(C3) Lack of Stakeholder Awareness		
(C4) Lack of Incentives		
(C5) Resistance to change by Stakeholders		
(C6) High initial cost		

Fig. 2. Challenges associated with the implementation of GBI in historical buildings
Source: Authors

The challenges mostly stem from concerns related to the predominant emerging themes are: (C1) Regulatory and Principles Constraints; (C2) Technical and Design Constraints; (C3) Lack of Stakeholder Awareness, recorded five times; (C5) Resistance to Change by Stakeholders; (C6) High Initial Cost, recorded three times; and finally, (C4) Lack of Incentives, recorded two times.

Eventually, the implementation of GBI criteria to historic buildings presents significant technical and architectural difficulties. The conservation of these structures to attain energy efficiency, water conservation, and indoor environmental quality frequently conflicts with their original design and materials. Most responders emphasise the possibility of destruction to important architectural elements during conservation efforts, thus undermining the building's historical validity. Furthermore, a persistent challenge in the implementation of GBI Initiatives for historic structures is the lack of congruence between sustainability principles and conservation legislation. GBI promotes building performance improvements that may require major structural changes, while the Malaysian National Heritage Act 645 (2005) prioritises material integrity and historical authenticity. This policy misalignment causes project teams to be uncertain and delays approval processes, resulting in regulatory limits. Both respondents agreed that green certification understanding and opinions are inconsistent and sometimes resistant. The interview found that a lack of technical expertise in applying GBI criteria to heritage buildings is a major barrier to using GBI for heritage projects Mohd Hanapiah et al. (2022). Moreover, historical conservation groups view GBI ranking sustainability as secondary to conservation, fearing green initiatives may harm historic building authenticity. Masrom et al. (2017) also noted that retrofitting existing buildings into green structures is more complicated and requires more expert fees for redesigning and installing green features than conventional construction methods, so the allocation of funds for operation and maintenance is relatively low compared to the new development budget.

5. CONCLUSION

In a nutshell, The GBI's adoption in historic building projects is hampered by environmental, technological, architectural, regulatory, and cultural concerns. Institutional and stakeholder issues further impede GBI implementation. Thus, interdisciplinary collaboration is needed to develop heritage-sensitive green technologies that meet sustainability goals and conservation principles, as well as integrated governance structures that promote conservation and sustainability. The strategic transitions from identifying challenges to investigating policy solutions promote a framework in which stakeholder values, including cultural importance and environmental accountability, are cooperatively negotiated during project design. Furthermore, an early integration enables conservation stakeholders evaluate GBI credits together. It appears to save costly rework throughout design when conservation constraints make suggested approaches unfeasible. The government must prioritise policy, guidelines, and regulations, standardise green building assessment tools, preserve cultural identity, promote environmental awareness, optimise the use of abandoned historical buildings, and achieve environmental benefits in order to push the national sustainable development agenda.

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7. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

8. AUTHORS' CONTRIBUTIONS

All authors jointly contributed to the research design, questionnaire development, data analysis, and manuscript preparation. All authors have read and approved the final version of the manuscript.

9. DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

AI tools (e.g, ChatGPT, Grammarly) were used for drafting, assistance, paraphrasing and grammar checking. All content was critically reviewed and edited by researcher.

10. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The datasets used and/or analysed during this study are available from the corresponding author upon reasonable request.

11. ETHICS STATEMENT

The authors declare that this research did not involve human or animal subjects.

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