Journal of Engineering Science and Technology
Special Issue on STAAUH, November (2024) 20 - 34

HBIM IN GEORGE TOWN WORLD HERITAGE SITE CONSERVATION: EXPLORING CURRENT PRACTICES, CHALLENGES AND STRATEGIES FOR ADVANCEMENT

ESTHER CHEAH YI TIAN, IZYAN YAHAYA*

School of Housing Building and Planning,
Universiti Sains Malaysia, 11800 Pulau Pinang, Malaysia
*Corresponding Author: izyanyahaya@usm.my

Abstract

Considering the site's rich cultural and historical significance, conserving heritage buildings within George Town World Heritage Site (GTWHS) is both delicate and challenging. Traditional conservation methods often fall short of addressing the complexities of these structures. Recently, Heritage Building Information Modelling (HBIM) has emerged as a promising approach, offering specialised solutions to enhance conservation practice. Despite its potential, HBIM adoption in Malaysia remains limited. This study investigates the current state of HBIM, identifying the challenges and recommending strategies for improving practices, focusing on GTWHS. A qualitative approach was employed, involving six (6) in-depth interviews with stakeholders experienced in heritage conservation projects within GTWHS. The findings reveal that HBIM is primarily used in high-profile conservation projects, while in some cases, specific HBIM tools are adopted. The research highlights four key challenges hindering HBIM implementation: technical, financial, organisational and project barriers. To overcome these challenges, the study emphasised the need for a collaborative effort involving individual stakeholders, firms, construction industry bodies, government agencies and educational institutions to effectively address the challenges and ensure the successful implementation of HBIM. This study provides valuable insight for heritage project stakeholders and academia on the crucial aspect that must be addressed in preparation for the transition to heritage preservation through implementing HBIM innovation.

Keywords: Conservation, Heritage building, HBIM, Georgetown World Heritage site.

1. Introduction

George Town, Penang, Malaysia, and Melaka were designated a UNESCO World Heritage Site in 2008 [1]. This recognition has increased tourism, boosting both states' economies and emphasising the importance of preserving their cultural and architectural heritage [2]. In Penang, conservation efforts focus on approximately 5,000 traditional shophouses that blend living and business spaces. Despite support from state and local authorities, conventional conservation methods have limitations in addressing the complexities of conservation activities [3].

Heritage Building Information Modelling (HBIM) has emerged as a promising solution for enhancing heritage conservation efforts. Unlike traditional BIM, HBIM incorporates parametric objects and semantic construction techniques for heritage building, enabling accurate digital modelling while maintaining authenticity [4]. However, over 80% of heritage buildings in Georgetown exhibit significant neglect, underscoring the dual challenges of maintaining these historical structures and ensuring their long-term conservation [5].

Despite HBIM's potential to improve heritage building conservation, its adoption remains low [6-8]. Previous studies primarily review HBIM's benefits and challenges but lack empirical insight from stakeholders involved in heritage conservations [6, 7]. Acknowledging the benefits of HBIM and the concerns regarding its low adoption, this paper aims to further investigate the current state of HBIM implementation with a specific focus on the case of George Town heritage site. Furthermore, the challenges and measures for enhancing HBIM practices in heritage preservation will be explored in greater depth.

2. Literature Review

2.1. Conservation project of heritage buildings in Malaysia

Conservation generally means preserving the original state of historical or cultural objects [9]. For buildings, conservation includes maintenance, preservation, restoration, reconstruction, and adapting historical elements to modern uses [10]. This process involves managing and understanding these elements to pass on heritage to future generations. In Malaysia, conserving heritage buildings is a joint effort between the government and private sector, led by the National Heritage Department [11]. Examples of conservation projects include the Kampung Kuala Dal Old Mosque, Kedai Mulong Mosque, the West Wall of Fort Cornwallis, the Dr. Sun Yat Sen Museum and Research Center, and the Penaga Hotel.

George town world heritage site

George Town has a rich urban history spanning over two centuries and is home to about 5,000 traditional shophouses that blend work and living spaces, reflecting its multicultural heritage. Conservation efforts by the Penang state government and local authorities culminated in George Town being designated a UNESCO World Heritage Site [6]. In Malaysia, heritage conservation adheres to guidelines set by international organisations, i.e. UNESCO, along with national laws and local regulations [12]. The Penang State Planning Committee oversees the Heritage Management Plan to protect the city's Outstanding Universal Value, supported by laws such as the National Heritage Act 2005 and the Town and Country Planning Act 1976 [13].

Conservation in Georgetown combines traditional approaches and modern technologies. Traditional methods are vital for maintaining authenticity but face a shortage of skilled workers [14]. Modern approaches like HBIM offer innovative solutions for documenting and managing heritage sites. Projects like HeritageCare demonstrate HBIM's potential to enhance conservation through detailed digital documentation and simulation.

However, barriers such as high cost, insufficient expertise and lack of standardisation limit its widespread adoption [14-16]. Effectively addressing these challenges requires collaboration among stakeholders. Government bodies, Georgetown World Heritage Incorporated (GTWHI), local conservators and community groups play crucial roles in bridging the gap between traditional practices and modern technologies [17, 18]. By fostering cross-disciplinary cooperation and embracing innovative technologies like HBIM, Georgetown can safeguard its heritage while adapting to contemporary challenges.

2.2. HBIM in conservation project of heritage building

2.2.1. Introduction to HBIM

HBIM has revolutionised heritage conservation by addressing key challenges in preserving cultural heritage globally [19]. Unlike traditional BIM, HBIM is specifically designed for historical buildings, utilising parametric objects and semantic techniques to ensure accurate digital modelling of heritage structures [4]. Dore and Murphy [20] emphasise that HBIM functions as a BIM plug-in, incorporating parametric objects from historical data sources, such as literature and archival documents.

This integration allows HBIM to be effectively employed in renovation, maintenance, and conservation projects. Additionally, HBIM will enable professionals to generate detailed 3D models containing historical and material information, further enhancing its application in heritage conservation [7]. The platform also facilitates collaboration among architects, engineers, and historians, while promoting public engagement and raising cultural heritage awareness through accessible digital models [20, 21].

2.2.2. Difference between BIM and HBIM

The literature highlights a clear evolution from BIM to HBIM, each addressing distinct needs within the construction industry. BIM, as described by Bryan and Antonopoulou [22] and Volk et al. [23], optimises collaboration and information exchange for efficient project management, focusing on planning, designing, and constructing new facilities. In contrast, HBIM, as defined by Ali et al. [8], adapts BIM concepts specifically for heritage buildings, addressing unique conservation challenges by capturing and modelling historical and architectural details. While BIM emphasises modern construction and facilities management, HBIM is tailored to conserve heritage assets and integrate historical and cultural data to aid conservation and maintenance planning [24].

2.2.3. HBIM in the Malaysian construction industry

In Malaysia, the adoption of HBIM in construction remains low due to the high skill requirements and industry inertia [4, 6]. Limited research on the technical

aspects of HBIM and its implementation challenges [25]. The concept is still relatively new, with minimal practical application. While HBIM has been employed to analyse building performance, its potential for conserving heritage buildings is mainly unexplored [7].

Globally, HBIM has demonstrated its versatility and effectiveness in various projects. In Europe, it was utilised in the Pavilion of Charles V project for data gathering and analysis [26]. At the same time, it was applied to structural analysis in the Villa in Poggio a Caiano, Italy [27]. Similarly, in the Town of Pollenzo, HBIM facilitated improvement in energy efficiency [28].

In Asia, HBIM proved valuable in facilitating the Tainan Confucian Temple for inspection and virtual learning [29] and enabled virtual experiences at the Doric Column project in Turkey [30]. In Malaysia, HBIM has been employed to visualise historical buildings such as Istana Balai Besar Alor Setar [6] and to streamline the quantity take-off process at Hilltop Private School in Johor Bahru [31]. It also facilitated data collection at Istana Seri Menanti and Istana Balai Besar Kota Bharu [32].

2.2.4. Benefits of HBIM in a conservation project

HBIM revolutionises heritage conservation by fundamentally altering the approach to cultural heritage preservation [33]. It facilitates seamless information exchange and decision-making, streamlines project coordination and enhances efficiency throughout the conservation process. By digitally preserving buildings, HBIM meticulously documents intricate architectural details and historical nuances, significantly reducing the time required for manual measurements and surveys [34]. Additionally, real-time project logs provide transparency and accountability, ensuring that stakeholders have access to vital project insights [35, 36]. The time-saving capabilities of HBIM not only reduce costs but play a critical role in maintaining the authenticity of historic structures.

2.2.5. Challenges of HBIM application

2.2.5.1. Technical challenges

The lack of documentation for historical buildings creates data gaps that hinder accurate HBIM data acquisition [22]. HBIM models require precise intangible data, adding complexity [20, 23]. Irregular shapes and intricate details of historical buildings present challenges for parametric geometries [37]. Issues such as the mixed pixel effect, especially around cracks and edges, can lead to inaccurate data and surface crack representation in HBIM modelling [38]. Furthermore, difficulties with laser scanners, such as fragility and scanning transparent or reflective objects, complicate the process [39]. These challenges require careful planning to ensure data accuracy.

2.2.5.2. Organizational challenges

Integrating BIM into heritage conservation faces organisational hurdles, particularly limited local use of BIM technology, which complicates 3D plan creation for conservation projects [8]. Implementing HBIM requires significant changes in workflows and roles [38], and compatibility issues between various data sources further complicate the process. Effective HBIM implementation requires

collaboration among architects, historians, conservators, and engineers, but communication issues and differing priorities often hinder progress. Engaging all stakeholders, including curators and non-technical participants, is vital but challenging without clear goals and simplified processes that align with the model's complexity [40].

2.2.5.3. Financial challenges

Financial constraints are a major obstacle to using BIM in construction and heritage conservation projects. Many organisations face budget issues that make it hard to afford necessary BIM resources like software licenses, servers, and tools. The high costs, including ongoing expenses such as annual renewals, often lead some to using unauthorised software to save money [41]. In heritage conservation, the costs are even higher because specialised BIM solutions for historical structures require significant investment. Budget limits can delay or restrict HBIM implementation, as funds are needed for software, equipment, and training, which may compete with other project needs [38]. Additionally, maintaining HBIM models can strain budgets due to costs for updates, data management, and system maintenance [40]. Organizations with tight budgets may struggle to invest in the technology and tools required for effective HBIM use [6].

2.2.6. Strategies for enhancing HBIM uses in conservation projects

Setting up specialised HBIM strategies is essential for improving its use in Malaysian conservation projects. While specific HBIM strategies are still developing, insights from general BIM practices outlined by CIDB Malaysia [42] can provide the foundation for improving HBIM use.

2.2.6.1. HBIM training

Establishing an HBIM training institute is critical to preparing professionals for HBIM implementation in conservation projects. The Malaysia BIM Report 2021 emphasizes the importance of such institutes for equipping future construction professionals [42]. These training programs should focus on raising awareness and understanding of HBIM among conservation professionals, addressing the shortage of skilled HBIM experts.

2.2.6.2. Financial Incentives

Financial incentives are essential for overcoming the financial barriers to HBIM adoption in heritage conservation. The Malaysia BIM Report 2021 highlights subsidies for training and financial support for organisations using BIM tools [42]. These strategies can be adapted to HBIM by offering financial support for HBIM-specific training and software acquisition, easing the financial burden on stakeholders and encouraging HBIM integration in conservation projects.

2.2.6.3. Development of application guidelines

Clear HBIM adoption guidelines are crucial to streamlining its integration into conservation projects. CIDB's BIM guideline can be adapted to create a structured framework for HBIM use. International examples, such as those from the UK and Singapore, can guide Malaysia in developing consistent guidelines. Resources like

the BIM Guide by myBI can help raise awareness and improve HBIM readiness, ensuring a systematic approach to heritage preservation [43].

2.2.6.4. Integration of HBIM within education curricula

Integrating HBIM into educational curricula is vital for preparing future professionals for conservation projects. Following Singapore's example, Malaysian educational institutions should offer specialised HBI courses alongside broader BIM training [43]. Collaboration among professionals, educators and researchers will ensure students have the knowledge and skills required for heritage conservation careers [44].

2.2.6.5. Increase HBIM Awareness

Raising awareness of HBIM is crucial for its adoption in heritage preservation. The UK's 2050 Group and Singapore's Centre for Construction IT have promoted BIM through youth engagement and educational events [43]. In Malaysia, promoting HBIM through BIM resource centres, online platforms and participation in events like the myBIM Roadshow and CIDB programs [45] will help to build a culture of HBIM and foster innovation in heritage preservation.

3. Research Methods

A qualitative research design was employed in this study. Snowball sampling was selected due to the scarcity of individuals with experience in HBIM for heritage building projects within the Malaysian construction industry. Six (6) respondents with experience in heritage conservation projects in George Town were interviewed. The number aligns with previous studies, which suggest sample sizes of around five participants are sufficient for reaching data saturation and generating meaningful insights [41, 43], thereby ensuring that the complexities of HBIM within the Malaysian context are well captured. Qualitative data were analysed using narrative analysis, wherein researchers interpreted and transcribed the respondents' verbal accounts into written text [46]. This approach allows a deeper understanding of the participants' experiences and perspectives as they share their responses.

4. Results and Discussion

4.1. Respondent's background

Table 1 summarises the background information of each respondent. For confidentiality reasons, the respondents' names have been anonymised and replaced with general codenames (e.g. Respondent A, B, C, D, E, and F). As shown in Table 1, the respondents include professionals holding significant roles within their organisations, comprising four (4) Directors, one (1) Manager, and one (1) Senior Associate. Respondent A is a Manager in the Department of Built Environment and Monitoring. Respondents B, D, and E are Directors, while Respondent C is both a Director and a Technical Specialist. Respondent F is a Senior Associate in a Culture-Based Department and a Building Materials Enthusiast. The varied roles within the companies ensure a broad spectrum of insight into the conservation of heritage buildings. All respondents have over ten (10) years of experience in heritage building conservation, indicating a high level of expertise and familiarity with the complexities involved in preserving historic structures.

Table 1. Respondents' background information.

Respondent	Age	Type of firm	Position	Experience (Years)
A	>40	Cultural Heritage Management	Manager	>10
B	>40	Contractor	Director	>10
C	36-40	BIM Consultancy	Director	>10
D	>40	Heritage Consultancy	Director	>10
E	>40	Heritage Consultancy	Director	>10
F	>40	Urban Regeneration	Senior Associate	>10

4.2. Current state of HBIM practices in GTWHS

Although some respondents claim they do not implement HBIM in their heritage conservation efforts, their use of certain tools suggests otherwise. Respondent A highlighted that government projects, such as those involving the Penang State Museum, have seen significant HBIM implementation, utilising tools like AutoCAD, PeGIS, and 3D laser scanning. Respondents C, D, E and F also acknowledge that advanced tools such as 3D laser scanning, photogrammetry, and BIM software like Revit are employed in the project.

However, Respondent B admitted that they have not fully integrated HBIM into their project but use AutoCAD as a base for creating 3D models. This suggests a focused application of HBIM in certain high-profile conservation projects, contributing to preserving historical integrity while integrating modern technology. This aligns with findings from Ali et al. [18], which highlight the slow but growing adoption of HBIM in Malaysia, as some respondents may not fully recognise that the advanced tools they use, such as AutoCAD and 3D laser scanning, are key components of HBIM despite the country's overall slower integration compared to European countries.

4.3. Challenges of HBIM usage

The findings in Table 2 reveal four primary challenges that hinder the application of HBIM in conservation projects in GTWHS: technical, financial, organisational and project barriers.

The technical challenges in HBIM implementation emerged as a significant theme in the interviews with Respondents B, C, D, and E, who emphasised accuracy issues in integrating manual data collection with digital modelling and assessing the structural integrity of heritage buildings. This finding is supported by existing literature, which identifies data voids arising from incomplete documentation and challenges in achieving precise data collection [20, 23]. The respondents also highlighted the challenges of the complexity of modelling historical structures, particularly in representing intricate details and non-standard components. As corroborated by Giuliani et al. [37], this process is not only resource-intensive but also time-consuming. Respondents E and F added issues related to data management and updating as another critical concern when using

HBIM. The literature also notes this challenge concerning ongoing data updates and historical data limitations [20].

The majority of the respondents also highlighted financial constraints associated with HBIM implementation. Respondents C and E specifically mentioned the high initial investment required for acquiring HBIM technologies such as 3D laser scanners, photogrammetry equipment, and specialised software. This finding is supported by research indicating significant costs related to HBIM adoption [40, 41]. Respondent A pointed out unforeseen costs, including licensing fees for extensive training programs, which align with broader financial constraints, particularly those related to the upfront investment. This is also echoed by Liu et al. [40].

In addition to these barriers, limited government funding and unequal accessibility of financial support to the conservation of heritage buildings within GTWHS were identified as further complications. Respondent F raised concerns about the ineffectiveness of subsidies for private companies, suggesting the need for more targeted financial incentives to promote HBIM adoption. These financial constraints echo the literature's call for a more equitable and strategic approach to support HBIM implementation effectively.

Financial limitations are a significant barrier to HBIM adoption across standard construction and heritage conservation projects. Many organisations struggle to secure the necessary resources, with high upfront and ongoing costs, such as software licenses and system upkeep, further complicating the implementation of HBIM for historical structures [31, 40, 41].

On the organisational front, communication and coordination challenges were identified as key barriers to HBIM adoption. Respondent E emphasised the difficulty in collaborating across departments, each with differing priorities and communication styles. Ali et al. [8] similarly highlight the need for cross-departmental collaboration to improve HBIM effectiveness.

Additionally, the majority of respondents identified stakeholder resistance to change as a major issue, with Respondents C and D attributing this resistance to familiarity with traditional methods. This resistance reflects the broader difficulty in driving a paradigm shift towards new technologies, a challenge echoed in the literature [40]. Furthermore, the lack of resources and staff training was noted as a significant organisational barrier to HBIM implementation, as seen in other studies [23].

At the project level, one of the key challenges is coordinating information among stakeholders during HBIM operations. The findings reveal that aligning diverse interests and inputs from various stakeholders complicates using HBIM for heritage conservation. Ali et al. [8] note that this challenge reflects a disconnect between the technology and the specific needs of heritage conservation projects.

Effective information sharing and integration across different platforms and stakeholders is critical, and failure to achieve this can hinder the success of HBIM implementation. This underscores the need for improved stakeholder coordination and tailored plans to address the complexities of managing heritage projects using HBIM.

Table 2. Challenges of HBIM uses in GTWHS.

Challenges	Details
Technical	Accuracy Issues
	Modelling Issues
	Data Management Problems
Financial	Funding Limitation
	Unforeseen Cost
	High Investment
Organisation	Communication Issues
	Lack of Resources and Training
	Resistance to Change
Project	Coordination Issues
	Poor Data Sharing and Integration

4.4. Strategies to enhance HBIM uses in GTWHS

Based on the data obtained, the respondents have recommended eight strategies to enhance HBIM adoption in GWTHS. These strategies are summarised in Table 3.

Table 3. Strategies to enhance HBIM uses in GTWHS.

Strategies
Training and Skill Development
Funding from Government
Creating Regulatory Guidelines and Mandates
Government Involvement and Proactive Role
Use of Outsourcing
Technical Improvement
Integrated HBIM in Education Curricula
Increased Awareness and Demonstrating Tangible Benefits

The respondents consistently emphasised that effective HBIM implementation depends on well-trained professionals integrating digital tools with traditional conservation practices. Training programs should equip professionals with the necessary skills to manage both the technical and practical aspects of HBIM. This approach would help connect advanced digital technologies with traditional conservation methods, ensuring a smooth transition. The CIDB [42] corroborates this insight, highlighting the need for specialised HBIM training institutes and the integration of HBIM into the academic curriculum as pivotal for developing a skilled workforce for advancing heritage conservation through digital means.

One significant barrier to the widespread adoption of HBIM is financial constraints. Respondents underscored that government funding and economic incentives are crucial for overcoming these challenges. Subsidies and grants can alleviate the initial cost of HBIM technology and ongoing maintenance. Respondent B articulated that *" incentives without strings attached "* are highly persuasive in encouraging stakeholders to adopt HBIM. Similarly, Respondent C emphasised the importance of securing continuous funding for technology

investment, maintenance, and training. These measures align with findings in the literature, highlighting the critical role of government financial support in reducing the financial burden on conservation projects and facilitating broader HBIM adoption [42].

Outsourcing specialised tasks like 3D scanning and data collection is further recommended to reduce financial constraints. This approach allows projects to benefit from advanced HBIM technologies without incurring high costs. Respondents noted that leveraging external expertise can optimise HBIM integration while controlling expenses. External service providers enable projects to access specialised skills and rent HBIM tools as needed, avoiding the high upfront costs of purchasing them outright. This innovative approach offers a practical method for heritage conservation projects to enhance HBIM integration while maintaining financial sustainability. It ensures that projects can leverage the latest HBIM advancements while keeping costs manageable and optimising outcomes.

The development of clear regulatory guidelines is essential for the effective implementation of HBIM. Respondent A highlighted the need for authoritative guidelines, including a detailed protocol for integrating documentation and graphical and non-graphical data. These protocols are necessary for advancing digital conservation efforts. Respondent D echoed this measure, noting that a clear framework would encourage widespread HBIM adoption. He further suggested that establishing authoritative guidelines can standardise practices and promote consistency across conservation projects. Zakaria et al. [43] support this view, suggesting that well-defined guidelines are necessary to streamline HBIM integration and address potential stakeholder conflicts.

Another frequently mentioned strategy was the need for proactive government involvement in promoting HBIM adoption. Most respondents advocated for government mandates and support to drive the integration of advanced technologies into conservation practices. This approach fosters stakeholder collaboration and aligns preservation efforts with cultural values, as previously emphasised by Zakaria et al. [43].

Several technical improvements are necessary to enhance the use of HBIM within GTWHS. The respondents repeatedly highlighted this theme during the interviews. A key recommendation is to engage various stakeholders, including consultants, contractors, workers, site managers, and project managers, to ensure HBIM tools align with real-world applications. By doing so, the technology can address the varied needs of those involved in heritage conservation, increasing its relevance and practicality. Respondent F highlighted that understanding these stakeholders' needs allows for the customisation of HBIM tools to be more practical and useful, addressing the specific requirements of each group. This engagement helps to design tools that simplify conservation workflows and enhance operational efficiency, as emphasised by Respondent A. By incorporating stakeholder feedback and conducting feasibility studies, HBIM tools can be better aligned with the unpredictable nature of heritage projects, ensuring that technology investments meet the practical needs of users and improve the overall effectiveness of conservation efforts.

Effective data management and performance optimisation are crucial for the successful application of HBIM in large-scale conservation projects. Historical buildings often lack proper documentation, leading to data acquisition challenges

that can compromise HBIM performance. Managing irregular shapes and intricate details adds further complexity, as Alshawabkeh et al. [38] and Bruno et al. [39] noted. Respondent C emphasised the need for HBIM tools to handle large datasets without affecting performance. Establishing a centralised data repository would improve access to accurate, up-to-date information, enhancing collaboration and workflow efficiency. This aligns with Zakaria et al. [43], who highlighted the importance of centralised data management for better project coordination.

Efficiently streamlining the HBIM process, potentially through automated solutions, is another crucial measure for enhancing its usage. Respondent A suggested that automating certain aspects could streamline operations, enabling quicker responses to conservation challenges. Digital representations and data handling improvements could help conservators and users rapidly address emerging issues. The potential for automation in enhancing expertise acquisition and operational efficiency has not been widely explored, presenting a novel direction for future research and development of tools to support large-scale HBIM adoption in heritage conservation.

Rising awareness and demonstrating the tangible benefits of HBIM are essential for fostering HBIM widespread adoption. Respondents emphasised that when the stakeholders fully comprehend the advantages and capabilities of HBIM, they are more inclined to support its integration into conservation practices. This includes demonstrating HBIM's benefits, such as improved accuracy in documentation, enhanced project planning, and more efficient management of conservation activities. Previous work reinforces the importance of awareness campaigns and showcasing benefits as effective strategies for promoting technological adoption [42]. Integrating HBIM into the educational curriculum is crucial for preparing future conservation professionals. Embedding HBIM training in academic programs ensures students acquire the skills necessary for modern conservation challenges. This is echoed in previous work, emphasising the importance of preparing graduates with digital methodologies essential for heritage conservation [44].

5. Conclusions

This research provides a comprehensive understanding of the current state of HBIM in GTWHS, highlighting the challenges and strategies to enhance its usage in preserving heritage sites. The findings identify four primary obstacles that hinder the application of HBIM in conservation projects within GWTHS: technical, financial, organisational and project barriers. Furthermore, the study highlights the need for a collaborative effort involving individual stakeholders, firms, construction industry bodies, government agencies and educational institutions to develop effective strategies to address the challenges and ensure the successful implementation of HBIM. Such an effort will improve HBIM’s effectiveness and support the broader goal of preserving the cultural and historical integrity of the GTWHS. This research makes substantial contributions to both industry and academia. It thoroughly understands the challenges and provides actionable recommendations for enhancing HBIM use. Furthermore, it expands the knowledge of HBIM by categorising the challenges and proposing practical solutions, thereby enriching the scholarly discourse on heritage conservation. Future research should focus on developing strategies to ensure HBIM remain adaptable and effective in meeting the dynamic demands of digital adoption for heritage conservation.

Acknowledgements

This study is supported by Fundamental Research Grant Scheme (FRGS) (FRGS/1/2023/SSI02/USM/02/1) awarded by Ministry of Higher Education Malaysia.

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