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Historic Building Information Modelling (HBIM): The Application of Digitalization in Conserving Negeri Sembilan Traditional Malay House

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Abstract

Rumah kampung, or Malay house, exemplifies the richness and insight of traditional buildings, sharing a home with people, and living in peace with nature. The typical Malay home is a building elevated on stilts high above the ground, covered with thatch roofs, encased with wooden walls, and pierced with windows and lattices in its most basic form. Due to the increasing interest in cultural heritage as a driving force of socio-economic development, many initiatives involving its preservation, conservation, restoration, and dissemination are undertaken throughout the globe. Conservation entails taking physical steps to preserve the fabric and elements of heritage buildings. It is a method of preventing deterioration from extending the life of buildings. According to the conservation concept, building conservation should maintain as much of the original building structure and fabric as feasible. Heritage buildings are now conserved based on historical and cultural considerations, and the cultural value of the architecture of historic buildings is slowly appreciated. The techniques, methods, and materials used to build and construct the buildings are the primary concern in conservation projects. This paper aims to investigate the current conservation process using the digitalization approach to document the Negeri Sembilan Traditional Malay House. Data collection involves a literature review, which will examine the current conservation process for cases in Malaysia and other countries. Content analysis was utilized to analyze the results. The findings of this paper provide helpful information regarding the potential development of digitalization based on the conservation process to be used further in the future of traditional conservation buildings.

Keywords

Traditional Malay House, Digitalization, Historic Building Information Modelling, Building Conservation

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Introduction

According to Noor Hayati Ismail et al. (2014), the traditional Malay house is strongly associated with the concepts of identity and evolution. This connection arises from the historical movement of people, which inherently left cultural imprints in the form of evolving lifestyles and architectural expressions. As communities migrated and adapted to new environments, they developed distinctive forms of vernacular architecture, of which the traditional Malay house is a significant example.

Wahab et al. (2019) state that the Negeri Sembilan Traditional Malay House (NSTMH) represents an evolved form of the Minangkabau ethnic houses originating from Sumatra. This study focuses on NSTMH due to its distinctive design and cultural significance. In Malaysia, traditional Malay houses are considered vernacular architecture, characterized by unique designs and materials that reflect the customs and lifestyle of the local population (Sulaiman, 2017). Therefore, preserving these houses is vital, as they represent the ingenuity and craftsmanship of communities prior to the advent of modern construction technologies.

Nationally, only a limited number of traditional Malay houses are listed as heritage assets. Specifically, with regard to NSTMH, there are currently no specific acts or regulations governing its conservation. Furthermore, there is a general lack of awareness and appreciation among some property owners regarding the cultural and historical value of these structures. As a result, many NSTMHs—some over 100 years old—have been abandoned or demolished without undergoing proper conservation processes. Although some owners attempt to preserve their homes, modifications often compromise the authenticity of the original architectural features.

Nonetheless, growing interest among individual researchers, academic institutions, and professionals, in collaboration with selected government agencies, has led to more structured efforts to conserve NSTMH. Recent studies have explored frameworks to support more effective conservation approaches. Therefore, this paper emphasizes the need to analyze current NSTMH conservation methods in order to evaluate existing patterns and to identify opportunities for improvement, particularly through the integration of digital tools.

One such tool is Historic Building Information Modeling (HBIM), which merges the principles of Building Information Modeling (BIM) with the preservation of heritage structures. Definitions of HBIM vary across countries, but it is broadly recognized as a specialized approach for creating visualization models and documenting conservation practices (Antonopoulou, 2017; Murphy et al., 2013). According to Murphy (2012) and Long et al. (2011), HBIM also functions as a semantically enriched database in which geometric models are linked to multi-source descriptive data. In essence, HBIM provides a shared digital representation of a building's physical and functional characteristics, supporting informed decision-making throughout its lifecycle (Murphy et al., 2013).

According to Baik (2017) and Mustafa et al. (2020), the HBIM process consists of two main stages, as illustrated in Figure 1. The first stage is the data collection phase, also known as the "learning phase," in which measurable information such as length, width, height, and other architectural elements is gathered using various tools and techniques. These tangible data are then

used in the second stage, known as the digital reconstruction phase, where a digital model is created. In the third stage, semantic enrichment and analytical assessments are conducted on the completed model. Finally, the fourth and most critical stage involves integrating the HBIM model into client workflows, with outputs tailored to specific project requirements.

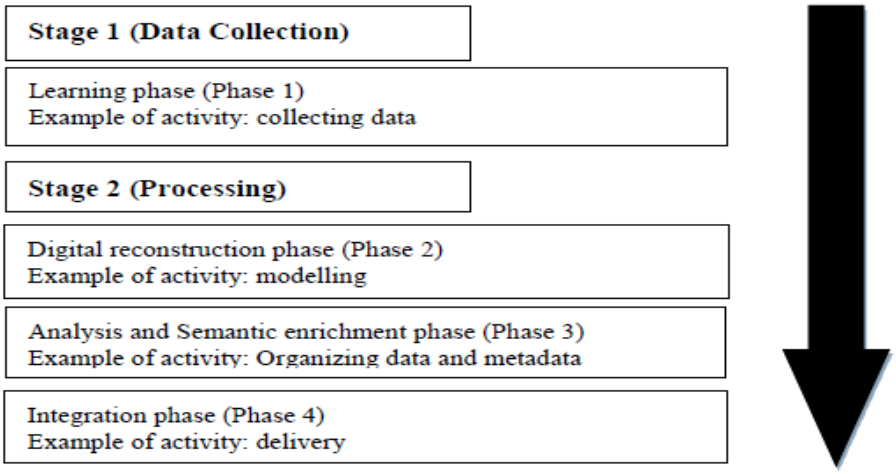

Figure 1. Process of HBIM stages (Baik, 2017, Mustafa et al., 2020)

In an alternative HBIM workflow outlined by Murphy et al. (2013) and Tang et al. (2010), the process is divided into three key steps: (1) shape modeling, (2) semantic modeling, which includes the recognition and categorization of architectural elements, and (3) the modeling of relationships between components. Most scholars agree that HBIM begins with the data collection of existing buildings, followed by the creation and enrichment of digital models, ultimately supporting the preservation and adaptive reuse of heritage structures.

Methodology

A comprehensive literature review was conducted to explore current conservation methods applied in Malaysia and other countries. This review involved an in-depth analysis of secondary data from various sources, including peer-reviewed journal articles, conference proceedings, textbooks, government reports, and doctoral theses. The collected data were analyzed using content analysis to identify trends, approaches, and challenges associated with the conservation of heritage buildings.

Results and Discussion

According to Jabatan Warisan Malaysia (2013), approximately 176 cultural heritage buildings have been designated as national heritage, with several of them undergoing appropriate conservation. In general, the conservation of traditional Malay houses remains limited due to low public awareness and appreciation. However, data show that several traditional houses in Negeri Sembilan have been conserved.

Mustafa et al. (2020) identified three main typologies of historical buildings in Peninsular Malaysia: palaces, aristocrats' houses, and commoners' houses. Each typology displays distinct characteristics in terms of layout and function. Digitalization based on the Historic Building Information Modeling (HBIM) approach involves techniques such as laser scanning, point cloud data processing, and the use of BIM tools like Autodesk AutoCAD, Revit, and Cubicost. Given the complexity and cultural specificity of traditional Malay architecture, digital conservation processes require tailored strategies that differ from those used in conventional buildings.

Table 1 presents a list of Negeri Sembilan Traditional Malay Houses that are more than 100 years old and have undergone conservation and documentation efforts by owners or authorities.

Table 1. The Conservation of Negeri Sembilan Traditional Malay House

No.	House name	Location	Ages	Method/Process of conservation	Method of Documentation
1	House of Raja Kamaruddin Raja Yaa'kob	Kg Terusan, Kuala Pilah	160 years	Relocation / Reconstruction	Manual and Digital Documentation
2	Rumah Maimunah Yaakub	Kg Penajis Tanjung, Rembau,	101 years	Relocation / Reconstruction	Manual and Digital Documentation
3	Teratak zaaba	Kg. Bukit Kerdas, Batu Kikir Timur, Jempol	>100 years	Preservation	Manual and Digital, 3D modelling
4	Rumah Tukang Kahar	Seri Menanti, Kuala Pilah	140 years	Relocation / Reconstruction	Digital Documentation, 3D Modelling
5	Rumah Hajjah Kundur	Rembau	>100 years	Relocation / Reconstruction	Digital Documentation
6	Rumah Datuk Baginda Tan Mas Mohar	Johol	171 years	Preservation	Manual and Digital
7	Rumah Datuk Klana Sungai Ujong	Rembau	150 years	Preservation	Digital Documentation

In other countries such as England and Ireland, the HBIM approach has been applied to various heritage buildings, including the Imperial War Museum and Woodseat Hall in Staffordshire (Antonopoulou, 2017). In the United Kingdom, an organization called Historic England spearheads many heritage conservation projects using the HBIM method. In Italy, culturally significant Roman-era structures such as the San Cipriano Church and the Santa Maria Church have served as case studies for HBIM-based digital documentation (Contonenza et al., 2018).

In Turkey, awareness about the importance of architectural heritage—particularly from the Ottoman Empire—has increased through summits and public discussions. HBIM is now being

recognized as a valuable tool for preserving such heritage, as it offers numerous long-term benefits (Baik, 2017).

Findings from this research indicate that the most commonly used conservation method in Malaysia is relocation and reconstruction. Additionally, 3D modelling is increasingly used in the preservation of traditional structures. For instance, the Teratak Za'aba project utilized 3D modelling to allow users to explore heritage architecture regardless of location virtually. Globally, 3D modelling has become a widely adopted method for the digital preservation of historical buildings.

The primary goal of 3D modelling in heritage conservation is to provide accurate visual representations of the original architectural form. This includes detailed features that replicate the structure's historical condition. The use of laser scanning significantly simplifies the modelling process by capturing accurate measurements. Furthermore, BIM tools such as AutoCAD and Autodesk Revit have been widely adopted due to their user-friendly interfaces and effectiveness in heritage modelling (Mustafa et al., 2020).

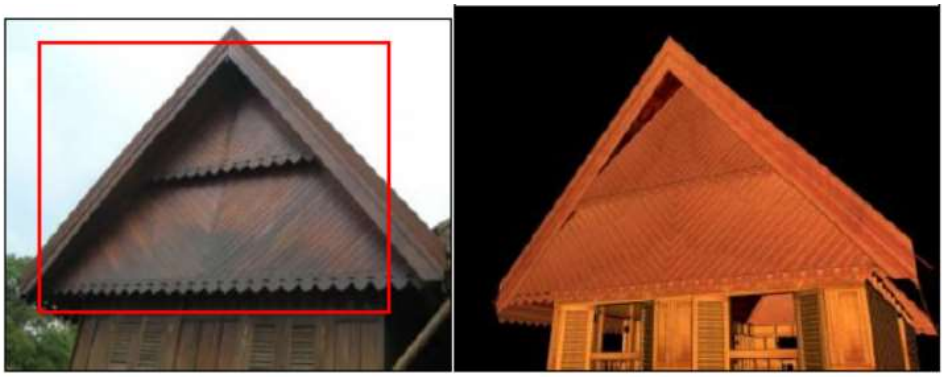

Figure 2. Tebar Layar of the Teratak Zaaba

Conclusions

Historic Building Information Modeling (HBIM) has been widely acknowledged in numerous studies as a valuable tool for the efficient maintenance and preservation of heritage buildings. From the perspective of governmental initiatives, there is growing anticipation that HBIM will be adopted for a broader range of projects in the future.

Based on the examples and analysis discussed in this paper, it is evident that the application of HBIM to heritage buildings in Malaysia remains limited and faces several significant challenges. Among these are the lack of suitable equipment, insufficient professional expertise, and, most notably, financial constraints. Furthermore, heritage conservation is inherently time-consuming, particularly due to the difficulties in collecting comprehensive historical data. Experts in the field understand that without adequate documentation of the building's history, it becomes challenging to determine the most appropriate conservation approach.

This study highlights the potential of HBIM to contribute meaningfully to heritage preservation efforts and to enhance the visibility and significance of this sector within Malaysia. It is recommended that further research be conducted to expand the knowledge base on the application of HBIM in heritage conservation, thereby enriching Malaysia's contribution to the global discourse on digital heritage management.

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