

# HBIM: Vernacular Architecture Study of Uma Kabuong Limo with Paranginan Roof Type

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## ABSTRACT

Kampung Pulau Belimbing, located in the Limo Koto area of Kampar Regency, is home to a variety of traditional Malay house forms known as Uma Kabuong Limo. Among these, a rare variant featuring a multi-tiered roof structure—referred to as the paranginan roof—represents a unique architectural development influenced by exposure to Malaysian Malay architecture. This study aims to document and analyze the typology of this vernacular building form using a qualitative-descriptive research approach, incorporating both synchronic and diachronic perspectives. Field data were collected through direct observation and interviews with local informants. These data were then translated into a digital model using Heritage Building Information Modeling (HBIM) via ArchiCAD software. The resulting model captures both the physical characteristics and symbolic meanings embedded in the building's structure, ornamentation, and spatial layout. The use of carved wood elements and high-quality materials further reflects the elevated social and economic status of the house owner. The study contributes to heritage conservation efforts by providing a digital reference for the documentation and analysis of culturally significant vernacular architecture in Riau.

**Keywords:** HBIM, Uma Kabuong Limo, vernacular



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## 1. Introduction

Traditional Malay architecture, as a distinct branch of Nusantara vernacular design, reflects the region's socio-cultural and environmental adaptations. The structural configuration, spatial hierarchy, and symbolic ornamentation of Malay houses embody local wisdom and customary law embedded within community life [1][2]. In Kampar Regency, particularly in Kampung Pulau Belimbing, one typology known as *Uma Kabuong Limo* serves both residential and communal functions. Characterized by stilted foundations, wooden structures, carved ornaments, and multi-pitched roofs, these buildings demonstrate typological diversity shaped by local practices and external influences. One rare variant is the *Uma Kabuong Limo* with a paranginan (multi-storey) roof, allegedly inspired by Malaysian architectural forms brought back by overseas workers. This architectural evolution not only represents aesthetic shifts but also symbolizes social mobility and cultural identity, particularly in urbanizing Malay regions such as Pekanbaru [3].

Preservation of such structures faces challenges due to physical deterioration, lack of documentation, and limited community awareness. To address these issues, this study applies Heritage Building Information Modeling (HBIM) as a digital tool for typological analysis and conservation planning. HBIM integrates

architectural data, historical insights, and modeling simulations, enhancing the documentation process of heritage assets. While Building Information Modeling (BIM) is well-established in contemporary architecture and construction [6][7][8], its adaptation for heritage—termed HBIM—requires a nuanced understanding of traditional forms and their intangible values [9][10][11][12][13]. Previous applications of HBIM in Europe (e.g., San Cipriano Church) and Malaysia have demonstrated its potential for non-invasive restoration planning and educational dissemination [11][12][13]. This research aims to analyze and digitally reconstruct the typology of the *Uma Kabuong Limo* with paranginan roof, thereby contributing to both architectural scholarship and the preservation of Malay vernacular heritage. The central research question guiding this study is:

*How can HBIM be utilized to model and analyze the typology of the Uma Kabuong Limo with paranginan roof to support its preservation as a cultural heritage structure?*

In doing so, the study combines descriptive fieldwork, architectural simulation, and qualitative interpretation to provide a comprehensive profile of this architectural form, grounded in previous studies on Malay architectural typology and restoration practices [4][5].

## 2. Method

This study investigates the architectural typology of the *Uma Kabuong Limo* with a paranginan (multi-level) roof, located in Belimbing Island Village, Kampar Regency. Positioned along the banks of the Kampar River—the largest river in the region connecting Limo Kota to surrounding areas—this building displays distinctive features in its roof structure and construction techniques, making it a valuable subject for typological analysis (Figure 1a–b).



**Figure 1.** (a) Location of research object (b) Research object of vernacular architectural building *uma Kabuong Limo* with level roof type

The research was conducted using a qualitative-descriptive approach. This methodology facilitates a holistic understanding of traditional architecture by capturing the socio-cultural context, construction practices, and transformations over time. Qualitative inquiry is suitable when addressing cultural values, local perceptions, and evolving heritage interpretations, particularly in communities experiencing modernization pressures [14] [15].

Data collection involved field observations and in-depth interviews with local residents, craftsmen, and cultural informants. The study applied both synchronic reading techniques, to assess the existing condition of the buildings in the present, and diachronic reading, which considers historical development and oral accounts [16]. These approaches helped trace the architectural evolution and external influences that shaped the paranginan roof variant. The study focused on seven *Uma Kabuong Limo* houses located across Belimbing Island Village. Each was examined for general characteristics and unique features, with special attention given to one house that most distinctly exhibited the paranginan roof type. The observed data were then processed into a digital simulation model using Building Information Modeling (BIM) techniques.

To ensure accuracy and integrity of documentation, the modeling was conducted using HBIM (Heritage Building Information Modeling), a specialized form of BIM that integrates historical and cultural information into digital 3D representations [13]. Modeling was performed in the architectural design laboratory using ArchiCAD 24, chosen for its parametric capabilities and GDL (Geometric Description Language) support. Through HBIM, the model simulates architectural form, spatial organization, material attributes, and construction details to closely match the real structure (Figure 2). In line with Groat and Wang’s architectural research approach [15], this modeling process served not only as a visualization tool but also as a method of analytical interpretation—connecting physical elements with socio-cultural meaning and enabling heritage-based decision-making for preservation efforts.

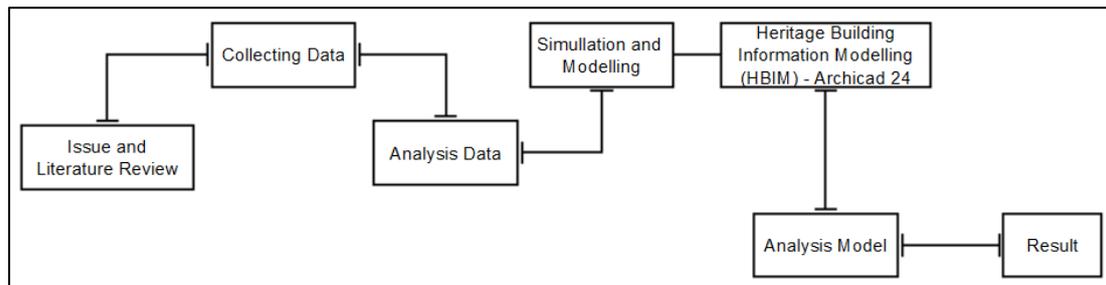


Figure 2. Research method

### 3. Result and Discussion

The digital modeling process was conducted using ArchiCAD 24 by Graphisoft, a BIM software suitable for detailing complex architectural elements. This platform facilitated the representation of traditional Malay vernacular architecture, including structural systems, ornamentation, and cultural spatial arrangements (Figure 3). Modeling accuracy was critical, especially for symbolic features such as carvings, where misrepresentation could result in cultural misinterpretation. The software’s Common Data Environment (CDE) supported interdisciplinary collaboration—an essential factor in heritage preservation workflows. Project settings such as layers, story heights, composite wall types, and profile managers were customized to suit the modeling needs. Carvings and stairs were created using morph tools, while composite tools were used to replicate the layered construction of traditional wall boards. Each building element, including windows, doors, and furniture, was built in GDL (Geometric Description Language) format to ensure interoperability with other BIM platforms.

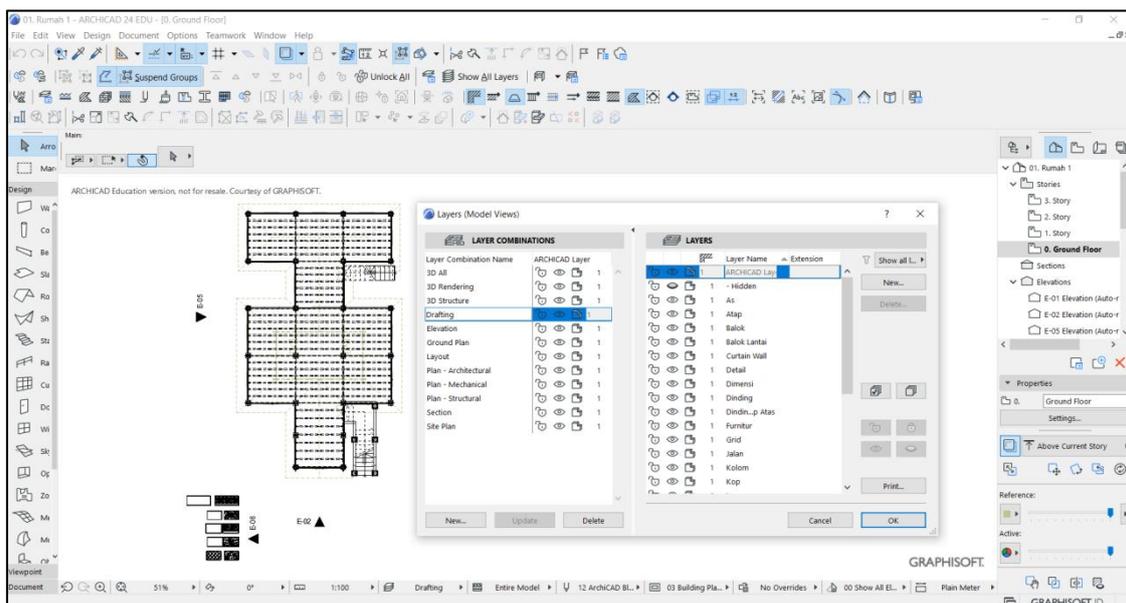
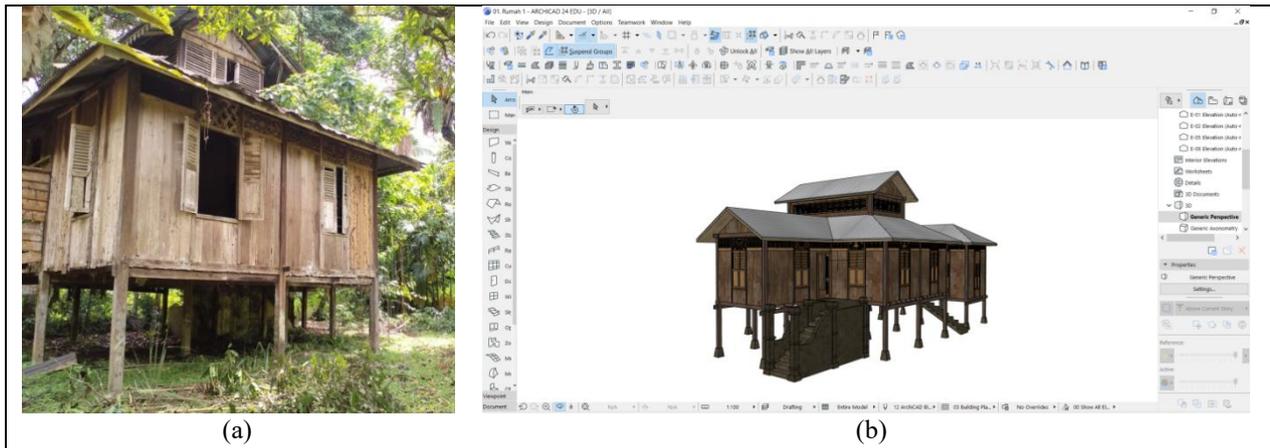


Figure 3. Building modeling on Archicad 24 applications

As shown in Figure 4, the original condition of the Uma Kabuong Limo structure was carefully documented and compared with the HBIM-generated model. Likewise, Figure 5 demonstrates the modeling of the building’s engravings and windows, highlighting both the accuracy and depth of digital replication. The building under study, identified as a residence belonging to Mr. Kiya’s family, retains the essential typology of a Uma Kabuong Limo despite its unique paranginan (multi-storey) roof. The elevated quality of materials—stone stairs, finely carved wood, and selected timber—reflects the owner’s high socioeconomic status. This roof type, distinct from other typologies in the region, was likely influenced by the owner’s experience working in Malaysia, where exposure to different forms of Malay architecture is common (Figure 6). The architectural significance of Uma Kabuong Limo has previously been discussed in the context of rehabilitation and heritage preservation efforts, highlighting its structural resilience and cultural symbolism [17].



**Figure 4.** (a) Original condition of the building (b) Building modeling form on HBIM

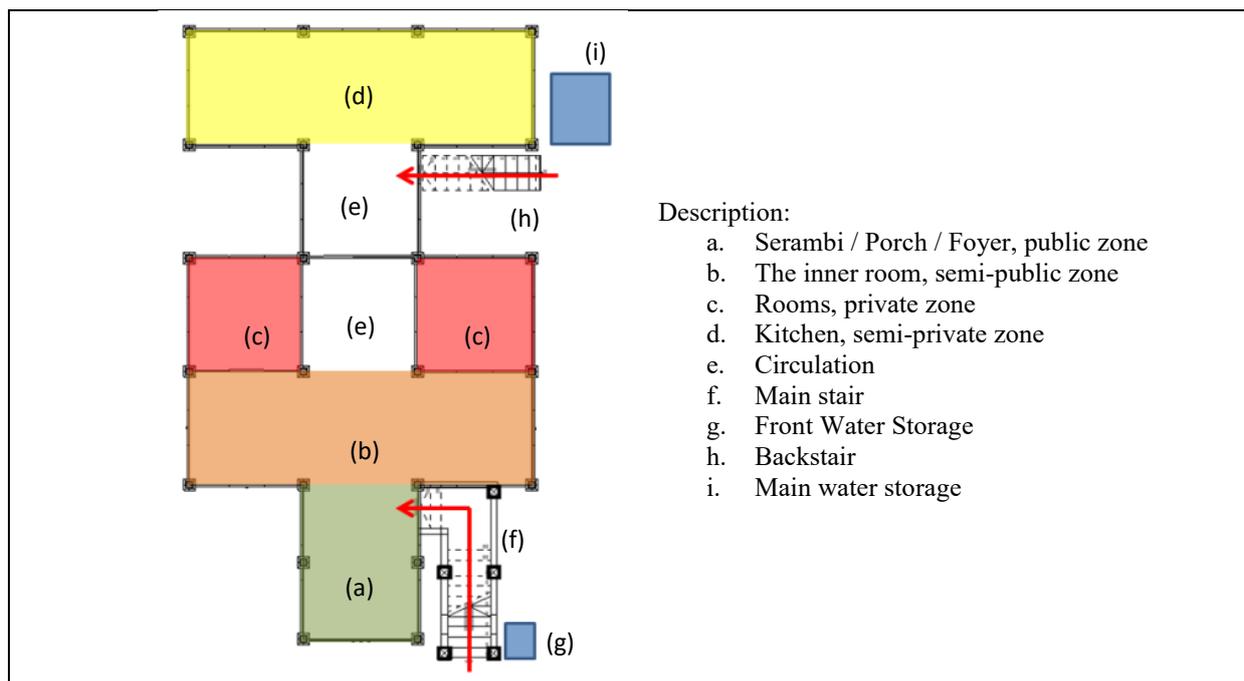


**Figure 5.** (a) Original condition of engraving and window (b) Window modeling on HBIM (c) Modeling of engraving details on HBIM



**Figure 6.** Typology of Uma Kabuong Limo buildings of multi-storey roof type

The house is located in the Lohgan Kampuung of the Domo tribe, and its north-south orientation is consistent with traditional settlement planning, optimizing ventilation and natural lighting from the adjacent Kampar River [18]. The building features dual entries: a formal front entrance (serambi) for ceremonial use, and a rear kitchen door for family and informal guests. As part of cultural practice, water storage tanks (kula) are placed near each entrance to enable foot washing (Figure 7).



**Figure 7.** Rooms function and zonation

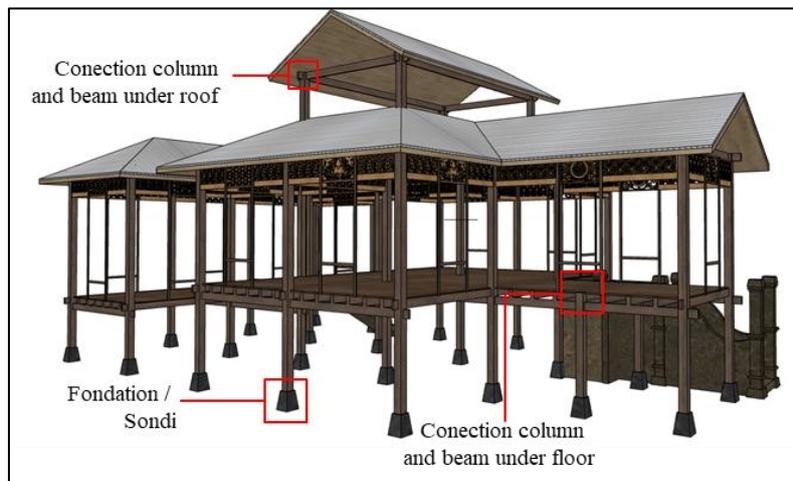
In terms of spatial zoning, the structure follows the traditional four-zone system: public, semi-public, private, and semi-private [5]. As illustrated in Figure 7, the house is divided into two primary sections: front and back, connected by a circulation space called *telo*. This corridor plays a dual function, serving both as a kitchen access and, during specific rituals, a passage for the deceased. The building also includes an upper ceiling space known as *salang*, used for storing valuables or food supplies. Figure 8 shows the front and side views of the building. The structure is elevated on stilts to mitigate flood risk and facilitate thermal comfort, reflecting the adaptation to tropical architecture principles [18]. The construction process incorporates communal labor (*gotong royong*), with building materials such as timber being pre-soaked in the river for several years to

improve durability. Traditional ceremonies accompany the construction, involving both male (*dunsanak*) and female (*sumando*) family members in designated roles.

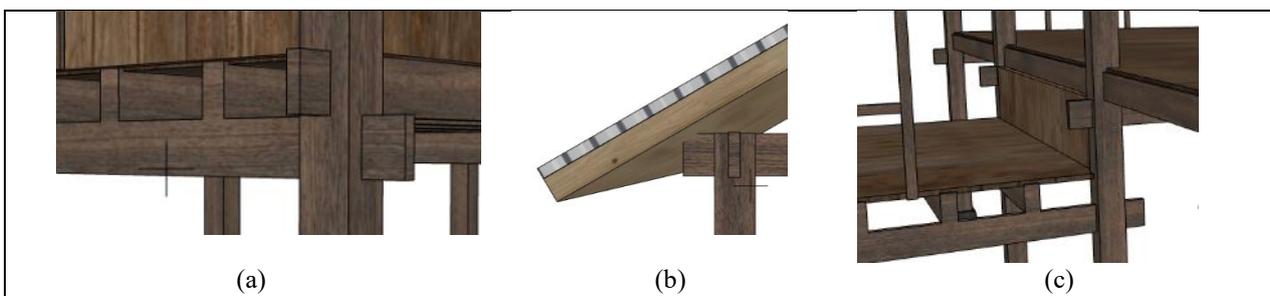


**Figure 8.** (a) Front view of the building (b) Side view of the building

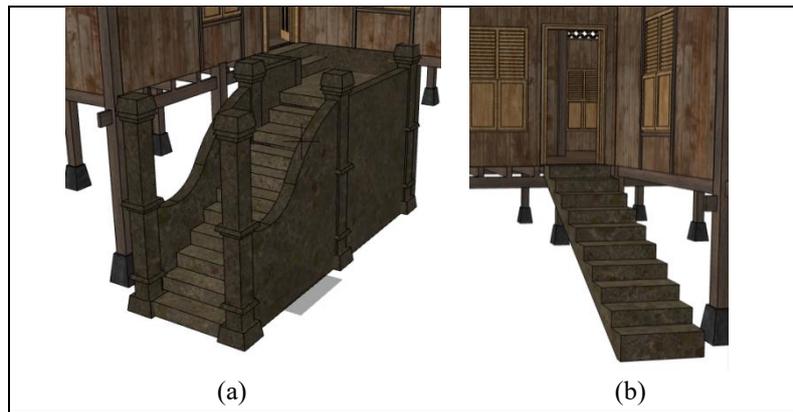
A breakdown of tectonic components is presented in Figure 9, showing the foundation (*sondi*), vertical supports, and roof trusses. The foundation is constructed using river stones or cement molds, while 24 columns are arranged based on function: 4 for the porch, 12 for the main space, and 8 for the kitchen. Structural elements are assembled with peg and knock-down joinery, consistent with traditional methods. The paranginan roof, shown in elevation in Figure 10, reaches a height of 8.2 m, whereas the first-level roof stands at 6.1 m. The building features two staircases with eastern orientation. The main front staircase, made of stone and cement, is used for formal entry, while the wooden rear staircase connects to the kitchen and is used by women and family guests (Figure 11). Each step of the main staircase is intentionally crafted to express symbolic meaning tied to the family’s status.



**Figure 9.** Tectonics of the Uma Kabuong Limo building

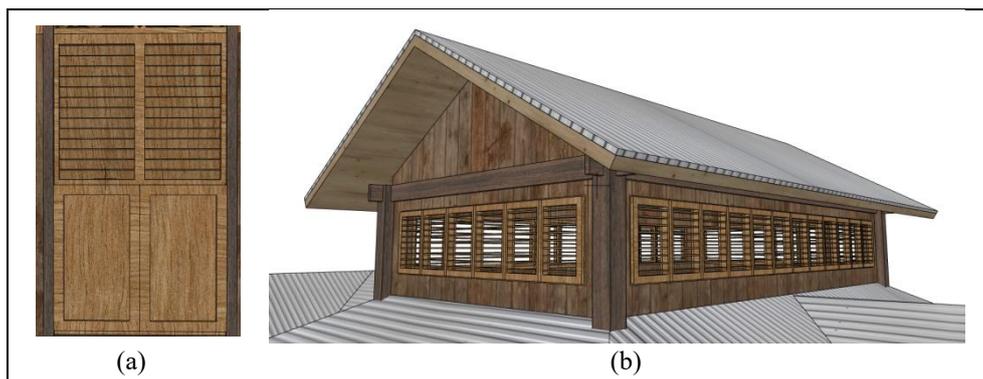


**Figure 10.** (a) beam pole relationship system, and floor (b) pole, beam, and roof relationship system (c) floor elevation

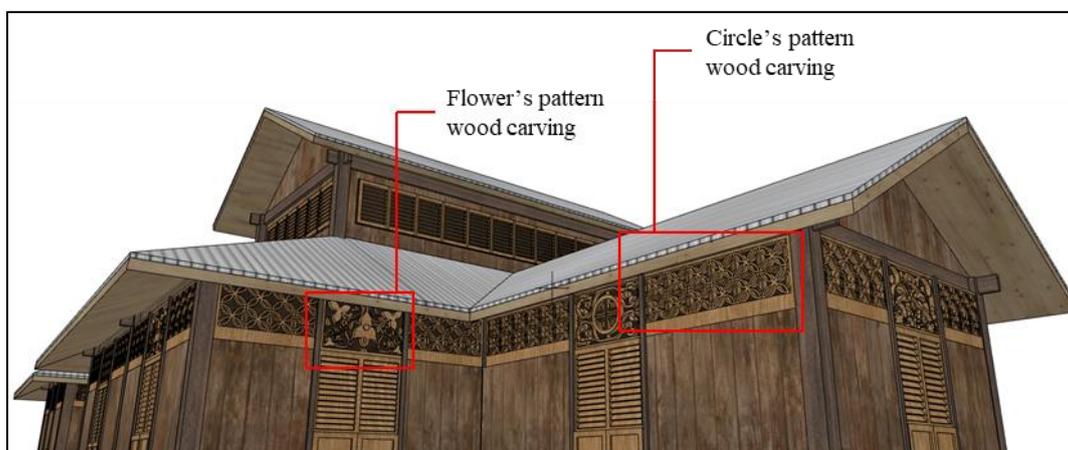


**Figure 11.** (a) Main staircase (b) Kitchen staircase

A significant number of windows are distributed across the house: 3 in the foyer, 6 in the main room, 7 in the kitchen, and 2 in the telo. These windows feature dual shutter systems with bottom closure and top ventilation grilles, allowing optimal airflow (Figure 12). The paranginan roof also includes grille windows—four on the sides ( $4.8\text{m} \times 0.6\text{m}$ ) and one at the front ( $2.5\text{m} \times 0.6\text{m}$ )—enhancing cross-ventilation. These features contribute to the thermal comfort inside the house. Ornamentation is a defining element of this building. As shown in Figure 13, floral carvings are located above windows, while circular motifs are arranged along upper wall panels. In line with previous studies [4], such carvings are not merely decorative but act as indicators of social hierarchy, revealing the family's prosperity and community role.



**Figure 12.** (a) Window (b) Grille



**Figure 13.** Wood carving on the building

Overall, the HBIM model successfully captures the typological and cultural aspects of the Uma Kabuong Limo with paranginan roof. It supports architectural heritage documentation by digitally encoding both tangible

structures and intangible values into a platform that enables conservation planning, historical analysis, and cultural education.

#### 4. Conclusion

The modeling of the Uma Kabuong Limo with a paranginan roof represents a significant effort in digitally documenting and preserving the typological diversity of traditional Malay architecture found in Belimbing Island Village. This architectural form embodies cultural identity, construction wisdom, and social symbolism within the community of Kampung Pulau Belimbing, making its preservation essential for safeguarding local heritage. The Uma Kabuong Limo serves not merely as a dwelling, but also as a reflection of its owner's social standing and economic position. Various structural adaptations—such as the adoption of a multi-storey (paranginan) roof—demonstrate how vernacular architecture evolves based on personal experiences and external influences, including exposure to architectural traditions from Malaysia. Despite the typological variation, the building retains core features found in other Uma Kabuong Limo types, such as the five-row structural grid supporting three primary spatial zones: the portico (serambi), main room, and kitchen. Functional elements like the lowered kitchen floor, designed to ease access to water for domestic use, exemplify the integration of practical needs into traditional forms. The tectonic structure—comprising the sondi (foundation), poles, and beams—supports both vertical and horizontal loads, ensuring structural stability while preserving aesthetic integrity. The presence of high-quality materials, fine craftsmanship, and ornamental carvings further reinforce the building's function as a marker of prestige. These cultural indicators are critical to understanding not only architectural techniques but also socio-economic narratives embedded within the structure. Through the use of Heritage Building Information Modeling (HBIM), the study successfully created a highly detailed digital representation of this unique building type. The ArchiCAD 24 platform enabled precise modeling of both structural and decorative elements using tools such as morphs, composites, and profile managers. This modeling process facilitates deeper typological analysis and supports various heritage conservation efforts by preserving both tangible and intangible aspects of traditional architecture. In conclusion, the Uma Kabuong Limo with a paranginan roof exemplifies a refined development within Malay vernacular architecture—both technically and symbolically. As revealed in this study, digital documentation via HBIM offers a powerful method for capturing and conserving such architectural legacies, especially those at risk of physical degradation. The outcome strengthens efforts to protect, study, and transmit regional architectural identity for future generations.

#### 5. Acknowledgments

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#### 6. Conflict of Interest

The authors declare that there are no conflicts of interest related to the publication of this article. The research was conducted independently, without any commercial or financial relationships that could be interpreted as influencing the results or interpretations presented herein.

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