

Original Article

# The Role of Heritage-BIM in the Integration of UII Library-Museum Design and Preservation of Kimpulan Temple

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**Abstract** - The concern of temples buried by nature's wrath in the Indonesian archipelago is of great untold historical value, and it is an archaeological wonder how so little is done for their preservation. Attempts to conserve these sites based on zoning methods are inadequate, as they both restrain possibilities for further construction and do not resolve the active construction problem at many archaeological sites. This research aims to assess the capability of Heritage Building Information Modeling (H-BIM) towards sustainable conservation practices using Kimpulan Temple as a case study. The case study approach was used to analyze the architectural achievement of the Library-Museum of the Islamic University of Indonesia (UII), which had the Kimpulan Temple as part of the architecture and space design. The design of the multifunctional educational center was the outcome of intensive cooperation and negotiations between archaeologists, builders, and other stakeholders. The end product was a dynamic educational facility integrating conservation, education, and active public participation. Within this context, "H-BIM" served not only as a tool for spatial zoning and integration of the archaeological-historical data but also for the simulation of design approaches sustaining both function and heritage. The results suggest that H-BIM has a meaningful contribution to the physical protection of archaeological remains while revitalizing temple buildings in the current architectural discourse. Supporting this conclusion, the study advocates for the more extensive use of H-BIM to preserve other archaeological sites in Indonesia for more effective, integrated, sustainable conservation approaches.

**Keywords** - Heritage BIM, Architectural decisions, Design, Preservation.

## 1. Introduction

Cultural heritage sites are valuable indicators of cultural identity and historical importance of a location. Their worth is not just in their buildings but in all that society invests in them, both material and immaterial [1]. Indonesia, with all its wealth of cultural heritage, has many ancient sites spread over every expanse. Nevertheless, protecting these sites, especially buried temples, due to natural disasters, e.g., volcanic explosion and/or tectonic movement, poses a significant challenge [2].

One lingering concern has been the unfinished restoration and development of the temples, including excavation to restoration and putting the structure to use. The main causes of this issue are limitations like a lack of integrated planning, a lack of resources, and a slow uptake of cutting-edge technological tools that could improve these sites' overall management [3].

Temples like Kedulan, Kadisoka, and Morangan are notable examples of this imperfect preservation. These locations are still not fully restored, which limits their ability to support tourism, education, and the preservation of cultural heritage in general. The current zoning strategy for these sites' preservation tends to emphasize their physical features rather than the potential long-term social, educational, and economic functions that these areas could provide [4].

One strategy to protect and manage these cultural resources is the zoning and delineation system used in the restoration of archaeological sites, including those with buried temples. Usually, this zoning is separated into multiple different categories: (1) The core zone, which includes the main temple buildings, is given priority for physical preservation and archaeological conservation; (2) the buffer zone surrounds the core area and serves to shield the site from outside threats or potentially harmful development activities;



and (3) the development zone, which lies outside of both the core and buffer zones, is used to build supporting infrastructure like tourist and educational facilities [5].

In order to reduce unplanned development near cultural heritage sites, the zoning approach is essential. Preservation efforts can be conducted with a targeted approach by clearly defining distinct zones, beginning with the core zone and extending to the development zone. With the framework provided by this zoning structure, the demands of conservation and the demands of educational and tourism activities are balanced [6].

Most zoning approaches to archaeological sites, their preservation cannot extend to the development zone. This is because it requires a lot of funds and rarely found experts such as conservators and archaeologists. Therefore, the restoration efforts of Kedulan, Kadisoka, and Morangan Temples stopped at the main zone but still focused little on the growth of functions in other zones. Actually, continuity is needed between the core zone, buffer zone, and development zone but is often ignored because the zoning approach is without careful planning. Therefore, without including educational, tourism, or public space functions, the restoration process often stops at the physical conservation stage [7, 4].

The underutilization of technologies such as Heritage Building Information Modeling (H-BIM) is another major issue. H-BIM is still not widely used despite the fact that it can significantly improve zoning planning and precise spatial definition. Planning and visualizing comprehensive development are hampered in the absence of integrated data. Furthermore, the preservation of these historic locations is in danger due to the mounting pressure of contemporary development, especially in urbanized areas or areas designated for infrastructure projects. These locations run the risk of being abandoned or relocated in the absence of strict zoning control [8].

A lack of knowledge and community involvement further exacerbates the problems with preservation. Local communities are frequently excluded from the zoning and restoration processes because conservation is seen as the province of the government or particular agencies. In actuality, community involvement is crucial to guaranteeing the sustainability of conservation initiatives over the long run [9]. Furthermore, many archaeological sites still lack development zones, meaning they only function as physical conservation sites with no additional value as places for cultural or educational interaction. This emphasizes how urgently Indonesian archaeological sites need to be preserved using more creative and comprehensive methods.

On the bright side, the rebuilding of the Kimpulan Temple is a remarkable example of architectural preservation, and the temple is perfectly incorporated into the design of the library

and museum at the Islamic University of Indonesia (UII). Discovered in 2009, the Kimpulan Temple site sparked creative architectural decision-making that produced a multifunctional space balancing temple preservation with public education and the contemporary roles of museums and libraries. This achievement opens up a chance to investigate how digital technologies might help to preserve like sites [10].

Particularly via a decision-making process that encourages in-depth cooperation among archaeologists, architects, and stakeholders, architectural choices are essential for the preservation of Kimpulan Temple. This approach guarantees the preservation of temples as historical artifacts and the development of functional and relevant spaces in a modern setting. Archaeologist participants are widely involved in integrating the preservation of cultural heritage and modern society's needs and harmony. They transform it into a spatial design that fully considers social and cultural aspects. This collaboration ensures that traditional values are not lost. The resulting spaces reflect identity and are full of history [11].

This design focuses on bringing different parts together to create one space that mixes education, culture, and preservation. Instead of keeping these things separate, the design combines them so they work well together. The space includes an area for showing artifacts, the UII museum, an educational gallery, and a place where visitors can interact with the history. All these parts help people learn more about culture and the past. By putting everything in one space, the design does more than just protect the Kimpulan Temple—it brings it back to life. The temple has become a part of today's world, still important and meaningful. It's a place where history meets modern life. Figure 1 shows the overall idea of how the UII Library-Museum is designed as one connected space. This way of designing shows a new way to keep historical places safe while also using them to teach and connect with people today.

Good design choices help keep Kimpulan Temple safe and meaningful for modern people. This shows a good way to manage heritage sites in Indonesia.

H-BIM is very helpful in this process. It can create 3D digital models of temples, show their real condition, assist in planning repairs, and provide accurate information. It also makes teamwork easier. H-BIM has been used in other countries to create detailed scans and 3D restoration models for sites like Notre Dame in France and Pompeii in Italy. It helps protect historic places by combining traditional knowledge with new technology. These digital models do more than show the structure; they also include historical and archaeological insights. With H-BIM, preservation teams can log current conditions, plan restorations, and think ahead for sustainable development. One of its strengths is offering a large digital archive accessible by various experts like

architects, conservators, public authorities, and archaeologists. Sharing this kind of information improves how conservation work gets done [8].



**Fig. 1 Integrated design concept of library-museum UII with Kimpulan temple**

We've seen how effective H-BIM can be in several global projects. A well-known case is its use in restoring Notre Dame Cathedral after the 2019 fire. Teams developed extremely accurate models, detailing even its decorations, and used old records to stay true to the original [12]. H-BIM was also key in bringing ancient Pompeii back to life. It supported both rebuilding and analyzing the site's environmental conditions [13]. It has also helped preserve sites like the Tomb of Cecilia Metella and Caetani Castle in Rome. These efforts mixed 3D tech, digital scans, VPL, and XR tools to build detailed, interactive versions of historic spaces. This technique works not only for big landmarks but also for smaller relics and artwork. H-BIM offers fresh insight into preserving heritage through a more engaging, in-depth method.

In Indonesia, using H-BIM needs special care because of the country's unique conditions. Many heritage sites here have fragile structures, are affected by natural disasters, and often don't have access to advanced technology or enough funding. H-BIM should be combined with traditional methods, laser scanning for hidden areas, and input from local experts to deal with these challenges. This ensures that the system works well with the needs of Indonesia's heritage.

At Kimpulan Temple, H-BIM helps create a design that honors the temple's history while still allowing for modern use. One big advantage is how it helps map out site zones clearly and makes restoration work faster and more accurate. Thanks to 3D scanning, H-BIM can capture both what we see on the surface and what's buried underground. Visible parts and what's underground. It also lets planners try different zoning layouts, like core, buffer, and development zones. These trial plans help ensure restoration is done responsibly and in sync with long-term goals [12].

Another strength of H-BIM is how it brings different data types into one platform. It pulls together findings from archaeology, building design, and historical records. This single database can be used by people across fields, including archaeologists, architects, conservators, and officials. Because everyone works with up-to-date, verified information, it leads to better and more unified decisions [14].

One of H-BIM's most useful features is a digital simulation, which plays a key role in deciding Kimpulan Temple's future design. Designers can test different scenarios with these simulations, thinking about sustainability, usability, and appearance in the long run. For example, simulations can check how a multipurpose space can balance the temple's new roles in conservation, education, and culture while protecting the building. Architects can try out ideas virtually and make better choices, ensuring the final design keeps the temple's original structure but also fits modern needs. H-BIM helps make the restoration and preservation of Kimpulan Temple more effective, cooperative, and lasting. This smart space design doesn't just protect the temple itself but also lets cultural heritage become part of today's society.

This study looks at how H-BIM can help keep Kimpulan Temple's cultural value alive while supporting its social use over time. It also explores whether this technology can be used at other cultural sites in Indonesia, offering a creative, sustainable conservation model to protect the country's rich history.

The main question of this research is: How can H-BIM be used to create a multipurpose reconciliation space that supports the long-term survival of Kimpulan Temple?

## 2. Materials and Methods

### 2.1. Case Study of Kimpulan Temple Integration with the UII Library-Museum Area

Material objects and formal objects are the two main but related categories into which this study divides its research objects. When assessing how well architectural design aids in cultural preservation, each is essential. The design process of the Islamic University of Indonesia (UII) Libraries and Museums and the preservation efforts of the Kimpulan Temple site are the two primary material objects that are the

focus of this study. Both of these components are essential for cultural and architectural heritage to be sustainable.

As a modern building, the UII Library Museum was created with a modular design that can grow in the future and serve a variety of scholarly and cultural purposes, including museum operations. This public institution doubles as a center for cultural preservation in addition to being a center for academics. The Kimpulan Temple site, which is in the center of the complex, is given special consideration during the design process in order to create areas that make it easier to manage and conserve cultural artifacts.

Another major focus of this study is the actual Kimpulan Temple site, which was unintentionally found while the UII Library and Museum was being built. Both the main temple and a smaller auxiliary temple, examples of Hindu architecture from the ninth century, have great historical and symbolic significance [10].

The location was found exactly inside the space allotted for the UII Library and Museum's construction. In addition to being unexpected, this discovery resulted in significant adjustments to the project's planning, especially regarding the functional and physical design, to preserve the Kimpulan Temple as an essential component of the overall architectural vision.

The formal object of this study is the achievement of architectural success, which is defined by the design process's capacity to smoothly combine function, form, and meaning to support cultural conservation. Kimpulan Temple was found by chance while building the UII library and museum. It's a 9th-century Hindu site with a main temple and a smaller one, both historically and culturally important. Since the temple was right where they planned the new building, they had to change the design to protect it but still make everything work well and look good.

This study looks at how they balanced function, style, and respect for the temple's meaning. The temple isn't just old ruins-it's part of local history, so the design had to include it carefully. They changed the layout, moved some rooms, used different materials, and added open spaces around the temple to keep it safe. The museum also has spots for visitors to learn about the temple and what was found there. They also checked how the building helps preserve the site, both inside and out, using tech and smart design to keep the temple in good shape while making it easy for people to visit and appreciate it. The key is mixing old and new without losing what makes the place special.

**2.2. H-BIM Digital Technology Implementation**

Digital tools like H-BIM also play an important role in planning and preserving the Kimpulan Temple site. H-BIM helps create accurate digital models of the temple and its

artifacts while also bringing together historical and archaeological data in one platform. This makes it easier for all experts involved to access and use the information.

When designing the UII Library and Museum, H-BIM is used to help preserve the Kimpulan Temple. One of the first steps in this process is setting clear boundaries for restoration. This helps define the main area that needs to be protected as the core preservation zone. The restoration plan was decided through discussions between experts and stakeholders, using H-BIM-based information to achieve a more accurate mapping of the restoration space zones.

The design refers to the initial position of the Kimpulan Temple when it was discovered to place the new building in the center of the site. To obtain a more accurate graphical representation of building elements, including quantity, size, shape, location, and orientation, the H-BIM model applied a level of detail (LoD) of 300 [15]. This level of accuracy allows H-BIM to provide in-depth information on the condition of the temple, resulting in effective preservation and more organized planning. Moreover, it becomes possible to examine the flowchart while applying the H-BIM related to the preservation of Kimpulan Temple. The H-BIM implementation flowchart can be seen in Figure 2.

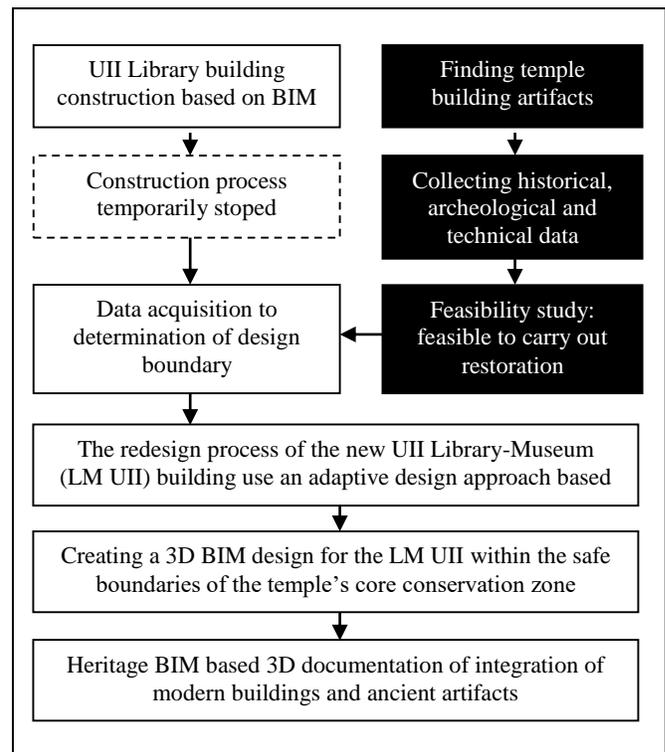


Fig. 2 Flow chart of H-BIM implementation

Applying H-BIM makes it easier to accurately map zoning areas and clearly define restoration boundaries, which helps thoughtfully blend modern architecture with historical

sites. For the UII Library and Museum, H-BIM supports a flexible and adaptive design that fully respects the presence of the Kimpulan Temple. This technology enables detailed digital modeling of both visible and hidden features, ensuring the temple's preservation is carefully integrated into the entire planning and design process. As a result, the design achieves a harmonious balance between modern functionality and cultural heritage preservation, making the site practical, meaningful, and sustainable. The main stages of H-BIM implementation, which show how the temple was successfully incorporated into the overall LM UII design, are illustrated in Figure 3.

Digital tools like H-BIM help modern buildings and heritage sites work well together. It's not about covering the old with the new but about letting both have meaning in the same space. At the UII Library and Museum, H-BIM helped shape a design that respected the Kimpulan Temple. Instead of seeing the temple as a problem, it became part of the design's main idea. Thanks to the adaptable nature of H-BIM, designers could map out clear zones for preservation, plan restorative measures with precision, and thread newer architectural elements in without overwhelming what was already there. That makes the whole approach more thoughtful and, more importantly, more sustainable.

This study examines how architecture deals with real-life surprises, like finding ancient sites, and how digital tools help make smarter design choices. When used well, H-BIM isn't just software. It becomes a bridge between old and new, between form and purpose. It helps designers weave together legacy and innovation in both a practical and symbolic way.

### 2.3. Research Methods

This research follows a qualitative case study framework chosen for its ability to capture the nuances and specific context of architectural work, particularly when it intersects with heritage conservation. Qualitative methods let us dig deeper than surface-level functionality, allowing us to explore what buildings mean and how they communicate value through design. Architecture isn't just about walls and roofs; it's about intention, about legacy, about continuity. That's why this method fits [16].

The case study zeroes in on two interlinked examples: the Kimpulan Temple and the UII Library and Museum. These aren't just buildings and ruins; they represent overlapping past and present stories. LMUII stands not only as a modern academic structure but as a kind of architectural response to KT, which was unearthed unexpectedly during construction. Instead of ignoring the discovery, the design was adjusted to include it. This rare combination shows us how two very different things can share one space without losing their meaning.

This analysis focuses on three key things: function, form, and meaning because these are what help a design truly fit its surroundings. The study also looks at bigger influences like cultural values, architectural styles, modern technologies, and the unique challenges of preserving heritage in Indonesia.

What makes this case special is how unique it is. Kimpulan Temple isn't just an old ruin. It's a story hidden underground for centuries and then found again. Meanwhile, the Central Library of UII (LMUII) is a modern building, but its design respects and connects with what's buried below. That kind of connection between the past and the present doesn't happen often, and it shows what good design can achieve. These two places remind us that preserving heritage

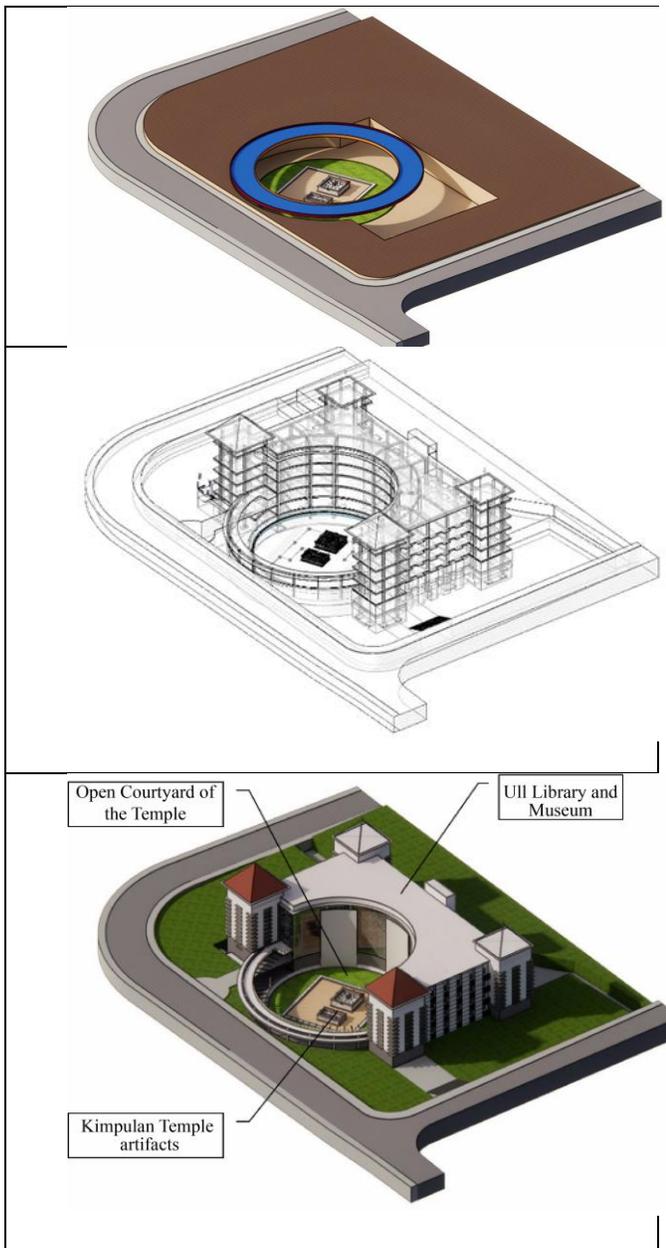


Fig. 3 The implementation of the H-BIM in Kimpulan temple

doesn't mean stopping change. It means finding ways for a new design to become part of the story, not compete with it.

Using H-BIM here isn't just about technology; it's a smart choice. It helped the team make digital models that showed both what's visible and what's hidden at Kimpulan Temple so they could make better decisions. Plus, it centralized all the archaeological, architectural, and historical data in one place. That kind of integration matters, especially when multiple stakeholders are involved. It gives everyone the same page to work from literally.

So, in the end, this case study does more than highlight a successful project. It contributes to a growing understanding of how modern design, aided by digital innovation, can meet cultural heritage not as a challenge to overcome but as a partner to work with. That's the heart of sustainable preservation and this research.

### 3. Discussion and Results

This section pulls together the core findings of the research, using the UII Library and Kimpulan Temple as a lens to examine how architecture can engage meaningfully with cultural preservation. The analysis pays special attention to how the design responds to unexpected discoveries, balances functional needs with symbolic value, and uses zoning strategies to carve out spaces for both old and new narratives. These are not just design choices; they're cultural ones.

The role of H-BIM is especially worth noting. It didn't just help create models; it helped create shared understanding. With its detailed digital scans and unified data platform, H-BIM enabled better coordination, clearer communication, and more forward-thinking planning. It's a tool that doesn't replace expertise; it amplifies it. And in contexts like KT and LMUII, that amplification matters. Because what's being preserved isn't just stone or structure; it's memory, meaning, and a sense of continuity that future generations can build on.

#### 3.1. Success Factors for Architectural Design in the Cultural Preservation

A thorough integration of function, form, and meaning at the LM UII demonstrates how well architectural design supports cultural preservation [17]. In addition to serving as a contemporary academic center, the building's museum features artifacts from the Kimpulan Temple, embodying a cultural mission. This multifunctional area fosters a greater understanding of cultural heritage while also improving educational activities.

A key component of the building's success is its adaptability, which allows for the smooth integration of traditional values with modern academic demands through a responsive and contextually driven design. Overall, the application of the adaptive design approach to the Kimpulan Temple at LMUII can be seen in Figure 4.

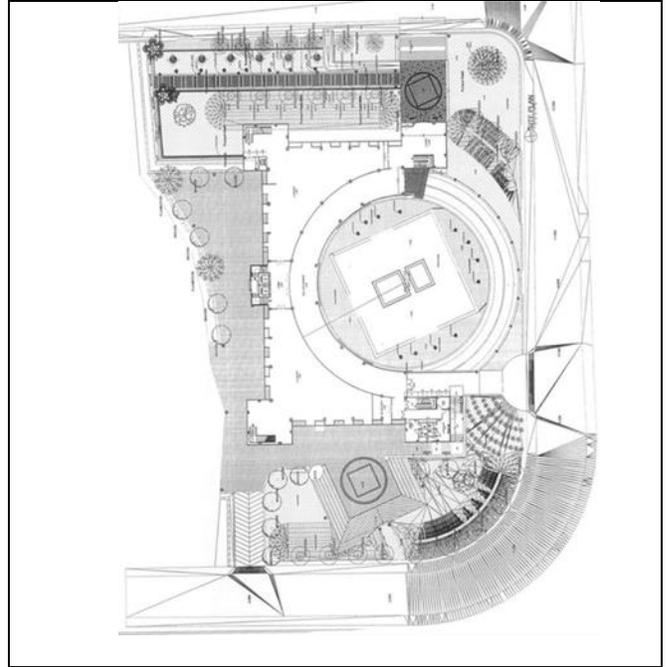


Fig. 4 The application of the adaptive design approach in the site plan

To thoughtfully engage with the cultural setting it inhabits, the architectural expression of the UII Library and Museum had to be more than just stylistic; it needed to respond. The design takes on this challenge by using modular strategies and flexibility, allowing the structure to mold itself around existing heritage elements, especially in zones where space and significance overlap. Instead of imposing itself on the site, the building adapts quietly and intentionally so its presence doesn't disrupt the visual or symbolic balance of the space. This is architecture that listens, not shouts. It's a kind of design that evolves through an ongoing dialogue with its context, be it physical, historical, or environmental, rather than being dropped in as a finished idea.

Just as crucial is the meaning embedded in the building's form. A building isn't just about how it looks or works; what it represents also matters. The result has a deeper meaning when modern design blends with something old, like the Kimpulan Temple. It shows that heritage isn't just something to look at behind glass; it can still be part of daily life, reinterpreted and included in new spaces. In this way, old sites aren't just saved; they're made relevant again and included in future stories.

Sujana [18] explains that being flexible is key, especially when things don't go as planned. The whole design had to shift when the Kimpulan Temple was found during construction. Walkways were moved, the building's shape was changed, and a new layout took form. An open plaza was added to fill space and as a quiet area that respects and protects the temple. It also gives people a place to reflect. The museum wasn't just

added for looks, either. It became a way to teach the public and keep the site active in an educational setting.

Similarly, Gumelar and Rully [5] say the zoning plan was very important. Dividing the site into clear zones core, buffer, and development helped protect the site. The core area stays untouched to protect the temple remains, while the buffer zone shields it from outside impact. And the development zone offers room for modern functions that won't compromise the integrity of the rest. It's a layered approach that balances caution with creativity and protection with progress.

Crucially, none of this would have come together without serious interdisciplinary collaboration. Architects didn't work in isolation; they worked shoulder-to-shoulder with heritage experts, archaeologists, engineers, and planners. That diversity of perspective meant the project wasn't just about solving a spatial problem; it became about crafting something that respected memory, acknowledged complexity, and responded with care. What came out of it wasn't just a building but a shared act of stewardship. A structure that doesn't just serve a present function but carries forward a legacy with depth and awareness.

### **3.2. H-BIM's Vital Contribution to Cultural Preservation**

Heritage Building Information Modeling, or H-BIM, plays a central role in the preservation of cultural heritage not just as a technical aid but as a way to rethink how we interact with the past [12]. Through H-BIM, highly detailed digital reconstructions of historic sites like the Kimpulan Temple become possible, capturing everything from the visible architectural elements to what lies beneath the surface. What this means in practice is that the entire physical reality of a heritage site, its shape, structure, and condition, can be digitally mapped and studied. That level of precision matters. It ensures that when decisions are made about how to restore or maintain the site, they're based on accurate information that respects what makes the site historically unique. Restoration, then, becomes less guesswork and more stewardship.

What sets H-BIM apart isn't just the precision, though it's the way it brings different types of data together. Archaeological field notes, old blueprints, historical archives, and architectural plans can all be folded into one unified digital model. Suddenly, everyone involved, whether they're archaeologists, conservationists, designers, or engineers, is looking at the same digital "truth." This shared model makes collaboration smoother and smarter. Fewer mistakes. Fewer assumptions. More clarity. Everyone's on the same page, and that leads to preservation strategies grounded in evidence that's been cross-checked from multiple angles [19].

There's also the issue of maintenance, which is something that's often overlooked in conservation discussions. With H-BIM, it's easier to track how a heritage site changes over time. The system allows for continuous monitoring, which makes it

possible to spot wear and tear early before it becomes a crisis. Whether it's damage caused by the weather, by people, or just by the slow passage of time, having real-time data helps prioritize what needs to be done and when. Instead of reacting to problems after they've grown, planners can take action early, avoiding costly emergency repairs and extending the site's life.

Beyond the technical benefits, H-BIM offers something just as valuable: a way to engage people. The digital models it generates aren't just for experts; they can be explored, visualized, and even experienced by the public. Virtual walk-throughs, reconstructions, and simulations bring places like the Kimpulan Temple to life in ways that books or photos can't. And that matters. It builds interest. It makes heritage feel alive and relevant. It helps communities connect to their history, not as something abstract or distant, but as something tangible and present.

Ultimately, H-BIM isn't just about preservation in the narrow sense; it's about sustaining a relationship with the past that can endure. The digital archive it creates serves not only today's needs but also the needs of future researchers, students, and community members. Even if parts of the physical site are lost to time, the knowledge, the layout, and the memory remain accessible and preserved in digital form. H-BIM, in that sense, is about continuity. It's about ensuring that cultural heritage doesn't fade quietly but instead stays part of the conversation generation after generation.

## **4. Conclusion and Recommendations**

### **4.1. Conclusion**

This study highlights the main factors that help Central Library UII and Kimpulan Temple keep their cultural heritage safe with good architecture. These are the design's ability to adapt to surprises like new archaeological finds, careful zoning, and a mix of function, form, and meaning. Together, they protect cultural values and make sure modern changes fit the historical background.

H-BIM is very important for sustainable preservation. It gives accurate digital models, combines many data, and helps plan and maintain sites better. H-BIM supports teamwork and design ideas like multifunctional spaces that connect past and present in one story.

The study shows that mixing modern architecture and digital tools like H-BIM is the smart way to save heritage. This method keeps history alive and allows creative designs for now and the future. It also shows how architecture plays a big role to respect and improve cultural sites.

### **4.2. Recommendations**

From the study, some suggestions to make preservation better:

- Mix form, function, and meaning deeply in designs. Balance practical, aesthetic, and symbolic parts so

heritage stays important but also fits today.

- Develop and use more digital tools like H-BIM, AR, VR, IoT, and AI. These can help the public enjoy and understand heritage better with interactive and real-time monitoring.
- Keep building teamwork between architects, archaeologists, and conservators. Have shared places to talk and decide to create new ideas and better preservation. Also, the community should be involved with education so locals can help protect sites.
- Governments should make policies to support the use of digital tools in preservation, with clear rules to keep standards the same everywhere.
- More research is needed to find ways digital tech can work on different heritage sites. This will help make flexible and creative preservation for many places.

### Conflicts of Interest

This research does not have any conflict of interest and is conducted to explore the success of architectural design processes that support cultural preservation. This research is novel and original in the case study of the buried Kimpulan Temple, specifically in examining the architectural design

process and the role of Heritage BIM in supporting integrated design and preservation. This research has not received any support or funding from any parties that may influence the research outcome.

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