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Heritage Building Information Modelling (HBIM) and Selogriyo Temple Conservation Area Mapping in WebGIS Experience Design

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ABSTRACT

Indonesia has many temples scattered throughout the archipelago, becoming important assets that need to be preserved. In accordance with Law No. 11/2010 on Cultural Heritage, preservation of cultural heritage requires documentation. The importance of documenting temples to anticipate damage is reflected in Selogriyo Temple which was affected by landslides in 1998. This research designed Heritage Building Information Modeling (HBIM) and conservation mapping of Selogriyo Temple based on WebGIS. Methods include Remote Sensing, Photogrammetry, and Geographic Information System (GIS). Secondary data in the form of 3D model of Selogriyo Temple from TLS acquisition was processed with segmentation for HBIM. HBIM WebGIS was designed using the waterfall method. HBIM WebGIS test was conducted through Validity Test, Reliability Test, and Feasibility Test of ISO 9126 standard. The results showed that segmentation using several software for divided the point cloud data into nine main parts of the temple. ArcGIS Online's CityEngine and SceneViewer software merged the sections and attributed information. Feasibility testing showed the 3D HBIM and WebGIS models were valid and reliable, with good consistency according to ISO 9126 standards. The score of each variable exceeded 70%, indicating a sufficient level of feasibility. The HBIM and WebGIS design provides information on temple construction, a reference for reconstruction, and supports the management of the Selogriyo Temple tourism area. This research product is expected to be used to anticipate future developments and advance the management of cultural heritage sites through smart heritage.

Keywords: Heritage Building Information Modeling, WebGIS, Candi, Terrestrial Laser Scanner

1. Introduction

Indonesia is a country that has many temples and is spread across the archipelago from almost the entire island of Java, partly in Sumatra, Bali and Kalimantan (Soekmono, 1995). The concept of temple distribution can be related to the pattern of government that existed at that time. The distribution of temples in various regions has become a tourist attraction in each region in Indonesia.

Selogriyo Temple is one of the historical relics of the Hindu period in Indonesia and is estimated to have been built in the 8th-9th century AD during the Hindu Mataram period. Selogriyo Temple is located on a hilltop in Campurejo Hamlet, Kembang Kuning Village, Windusari District, Magelang Regency. The history of Selogriyo Temple was discovered in 1835 by the Magelan Resident named Hartman and began to be excavated in 1955 for two years (Sularso, 2014).

Temple buildings can be damaged by natural disasters, history records that Selogriyo Temple was affected by a landslide in 1998. The temple needs to be preserved and documented because it is an object of historical heritage and an asset of the nation's wealth, based on Law Number 11 of 2010 article 53 paragraph 4 concerning Cultural Heritage, in its preservation there is a need for archiving in the form of cultural heritage documentation. The pattern of temple management prioritizes the exterior rather than the interior (Lim, 2017). Therefore, management in the form of digital archiving of the Selogriyo Temple model is important to do.

According to Maysyaroh (2022) the Tourism Sector during 2010-2019 contributed to contributing Regional Original Income (PAD) in Magelang Regency with an average value of 8.05 percent. When referring to the classification of contribution criteria issued by the Ministry of Home Affairs, Ministry of Home Affairs No. 690.900.327, the range of 0 - 10 percent is included in the category of contribution that is still very lacking (Maysyaroh, 2022). This should be improved by attracting visitors to tourist attractions. Visitors who visit tourist attractions can generate the economy around tourist attractions. The temple is not limited to buildings, but also the area around the temple needs to be preserved. The temple area has boundaries that can distinguish it from the area outside the temple, with references obtained from the location of the temple, which is near a water source, and from the discovery of stone parts and temple statues in the area (Hatmadja, 2006). The importance of preserving temple areas and buildings, the absence of mapping of temple areas and 3D mapping of temples is a problem in the future. This is useful, among others, in the process of reconstructing the physical building of the temple in the event of a disaster and needs mapping that determines the boundaries of the area to protect the findings of temple parts.

Based on Victoria Andrea Cotella's research on From 3D Point Cloud to HBIM, in 2023 revealed that digital technology plays an important role as a tool for cultural heritage documentation, one of which is the application of HBIM and GIS interoperability. Juan Moyano's research, in 2021 on 3D modeling of the historic building Faada Casa de Pilatos Palace 16th century Seville (Spain) can use Terrestrial Laser Scanner. Parametric as-built 3D modeling of data acquisition for the surface of a historic building complex. Research from Santosa, in 2021 revealed that the use of 3D laser scanning technology can accelerate the process of recording and modeling HBIM library objects, offering high accuracy and efficiency in recording complex structures and architectural elements. The final result of HBIM modeling is translated into interactive presentation of 3D models and documentation of Historic Building Information through the HBIM mobile data viewer.

HBIM design and area mapping of Selogriyo Temple will be made by combining Remote Sensing, Photogrammetry and Geographic Information System (GIS) methods. The processing uses secondary data of Selogriyo Temple 3D model from TLS acquisition. The 3D model data of the temple used for HBIM is processed with the segmentation method (Moyano et al., 2021). HBIM of the displayed building is accompanied by information, so that users can understand information on historical buildings. HBIM is formed from one object divided into several parts of the building (segmentation). In order to create an integrated model for conservation activities, Geographic Information System (GIS) software suitable for model visualization is ArcGIS. The results of Heritage Building Information Modeling (HBIM) will show the building divided into several parts and there is information on each component in Selogriyo Temple. The HBIM model will then be made WebGIS-based and tested for feasibility using a usability test (Supriyatna, 2018; Nugraha et al., 2015).

This research aims to make the research product can be used to anticipate future developments and advance the management of cultural heritage sites through smart heritage. The design of Heritage Building Information Modeling (HBIM) and mapping of Selogriyo Temple area based on WebGIS can also provide information about temple construction, allowing for future reference of temple reconstruction and Selogriyo Temple area, Magelang Regency.

2. Data and Methods

2.1. Data and Location

The data that will be used in this study is secondary data, the following are the data that will be used.

1. Selogriyo Temple 3D Model data obtained from previous research by Wira Maulana Ashar related to the accuracy of 3D modeling using the Terrestrial Laser Scanner in 2024
2. Zoning Data on the Boundary of the Selogriyo Temple Area obtained from the Central Java Cultural Heritage Preservation Center Agency

The location of the research is Selogriyo Temple in the interior of Windusari District, Magelang, Central Java. Located between Bukit Condong, Giyanti, and Malang, Selogriyo Temple is located at 7°25'28.60" South Latitude and 110°10'3.50" East Longitude. One of the fastest ways to get to Selogriyo Temple is to pass through Bandongan District and follow the signs to the temple. The forest connects the south side of Selogriyo Temple. You can walk to the temple on the east side. To the north of the temple are trees, local rice fields, and an unknown waterfall that is about two kilometers away. The display of the location of the temple can be seen in Figure 1

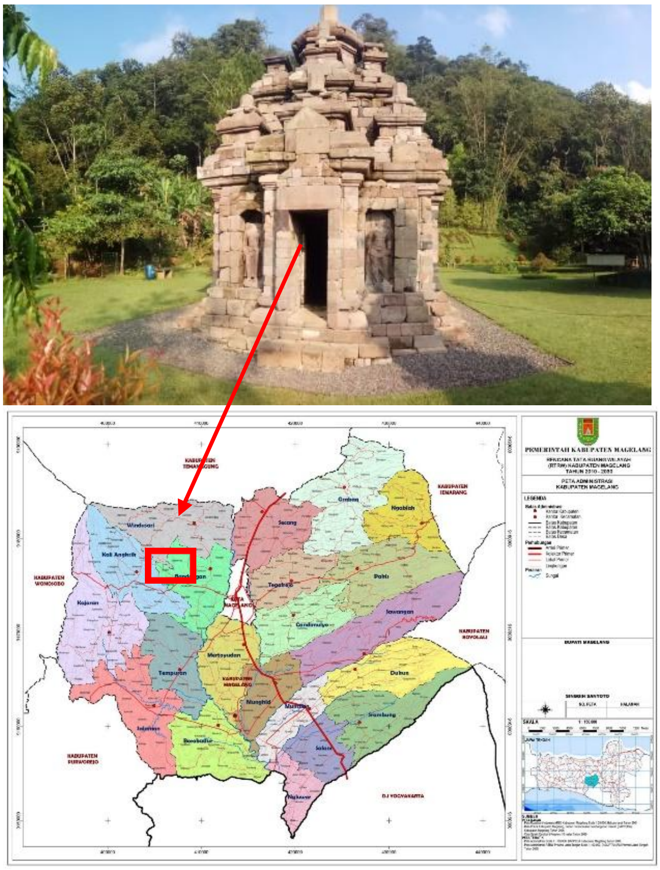


Figure 1 Selogriyo Temple As Location Of The Research

2.2. Methodology

2.2.1 Preparing Steps

Before starting the research, several preparations were needed to make the research run smoothly and appropriately. First, a literature study was conducted to understand and explore the concept of 3D temple modeling, 3D modeling methods, 3D model segmentation tools, HBIM modeling, and the use of low-code WebGIS design applications. The literature study also included a review of previous research and information on temple objects and cultural heritage areas. Second, a preliminary survey was conducted around Selogriyo Temple, Magelang Regency, to find out the field conditions and take care of licensing, including taking pictures of temple parts decorated with various components. Finally, data and tool preparation include the collection of acquired data (TLS) and the preparation of processing tools such as computers and software. This research will use secondary data and cameras to complement the information of HBIM and WebGIS research objects.

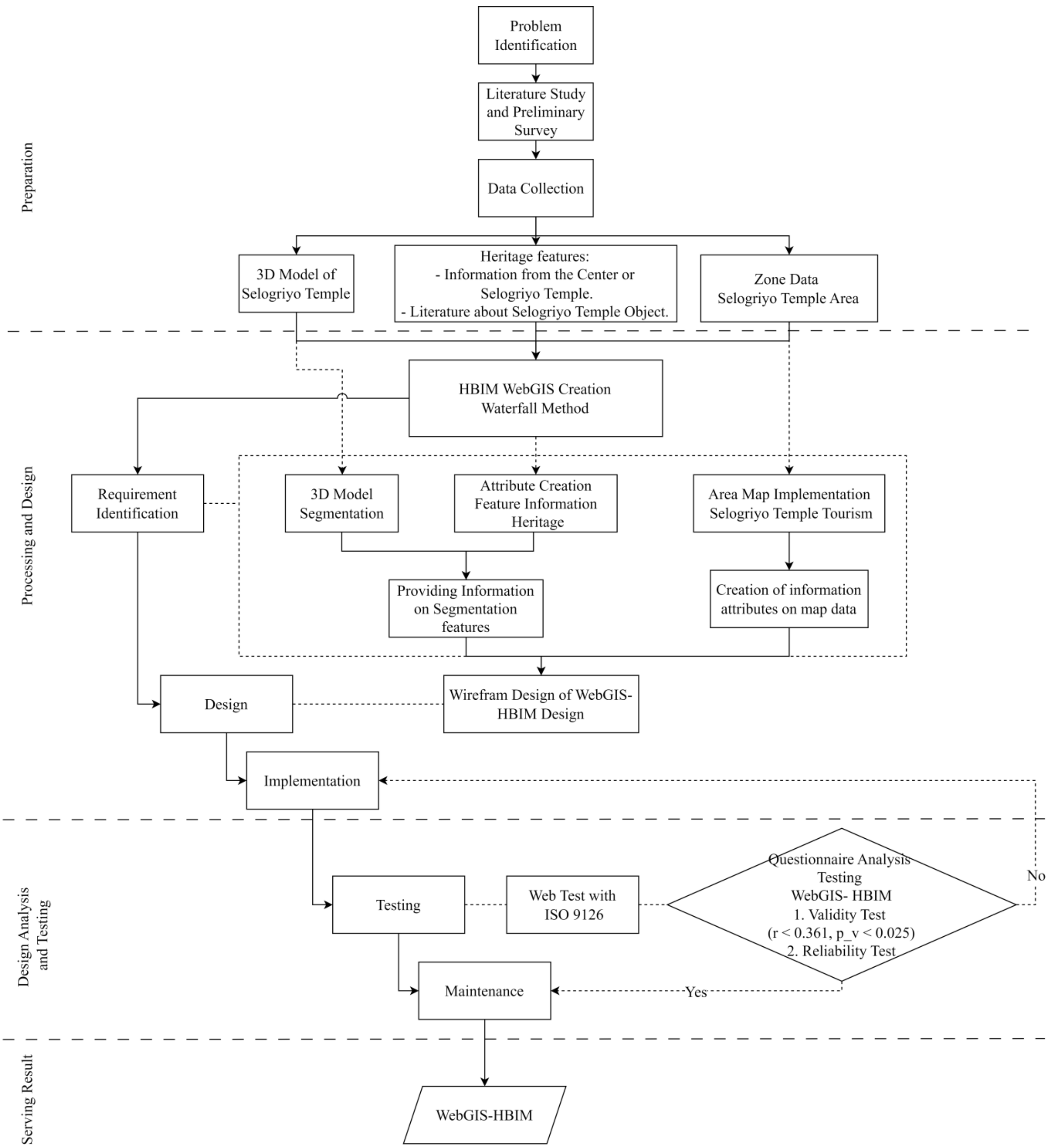


Figure 2 Flowchart of Research Methodology

2.2.2 Processing and Design Stages

The 3D object segmentation processing of Selogriyo Temple aims to classify the temple into nine parts: temple foot, temple body, temple roof, Mahakala statue, Nandiswara statue, Durga statue, Ganesa statue, Agastya statue, and temple door. The segmentation process involves grouping the point clouds, mesh processing and texturing, exporting the segmentation, and assigning attribute information to each part. The 3D model data used came from 2024 research using the TLS tool.

The creation of the Selogriyo Temple area map was carried out using ArcGIS Online to visualize supporting locations in the temple area. The steps include digitizing supporting accommodations such as mosques, roads, and parking lots, and filling in attribute information on each spatial feature. After digitizing, the data was integrated into the database and ArcGIS Online Map Viewer to create an interactive area map with information pop-up features on each object.

HBIM WebGIS design uses the waterfall method with the following explanation based on the Figure 3.

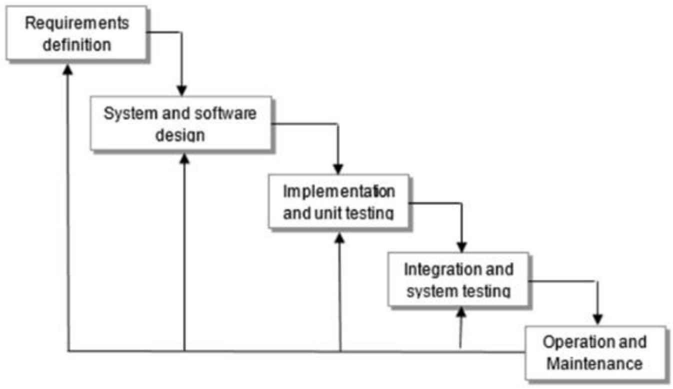


Figure 2 Waterfall Method Schema (Pressman, 2012)

a) Requirement Identification

The process of identifying needs for web design not only includes general needs in the HBIM WebGIS, but also considers specific needs based on suggestions and input from agencies related to Selogriyo Temple. The author has previously made a prototype of the designed web as an overview that will be visualized on the web. The prototype design was then presented to resource persons from the agency to get suggestions regarding the needs that need to be displayed on the web.

b) Design

This design stage is designed using application and platform architecture preferences, web modeling systems, and interface design. System architecture The web structure is designed using several important components in the WebGIS design architecture system. In this case, ArcGIS Online, Map Viewer, Scene Viewer, and Experience Builder are used.

Table 1 Architectural System

Architectural Components	Function
ArcGIS Online	As the main platform for managing and analyzing geographic data. ArcGIS Online enables interactive mapping, spatial data storage, and information sharing with other users.
Experience Builder	A platform for creating interactive and responsive web applications. Experience Builder enables intuitive interface design, incorporating a variety of widgets and features to improve user interaction with spatial data and HBIM 3D model data.
Map Viewer	A tool used to view, explore, and interact with a map that has been created. Map Viewer allows users to interact with layers, perform simple analysis, and adjust the map display of the supporting area of Selogriyo Temple as needed.
Scene Viewer	It is used to display data in 3D geographically. Scene Viewer allows visualization of 3D HBIM models of Selogriyo Temple, providing users with a more immersive and realistic experience.

The stages of creating a web design will outline user interaction use cases such as creating a web home panel design, a map of the temple area along with accommodation information, and a 3D model of HBIM. In Figure 4, the web design plan is shown as follows.

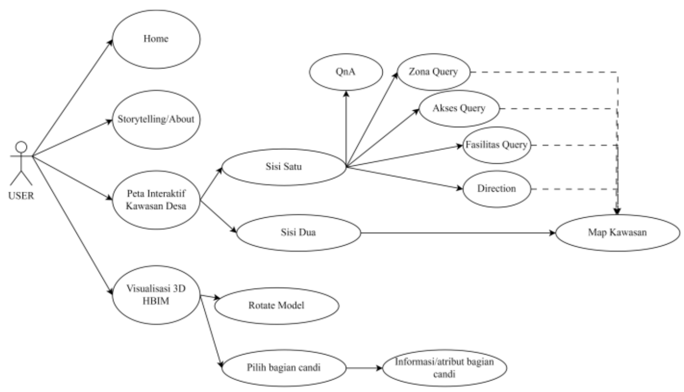


Figure 3 Use Case Diagram

Here are some of the initial designs of the main page layout designed for the website that will be used to convey information about Selogriyo Temple.

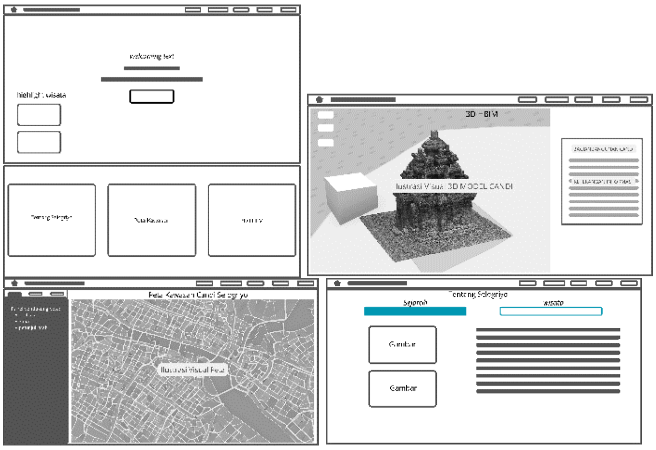


Figure 4 Interface Web Design

c) Implementation

Implementation is done by adding widgets and interactive features using Experience Builder. Compatibility testing is carried out using SortSite, while testing based on the ISO 9126 standard includes functionality, reliability, usability, efficiency, maintainability, and portability

d) Testing

WebGIS HBIM testing is conducted through a questionnaire distributed to users to assess websites based on the six variables of the ISO 9126 standard. Validity and reliability tests are carried out using the R Studio application.

Validity is calculated using the product moment correlation technique. The technique uses a method of connecting the total score of each respondent with each variable (Notoatmodjo, 2002). The product moment correlation technique can be seen as in Formula (1) Correlation Coefficient Formula.

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{\{N\sum X^2 - (\sum X)^2\}\{N\sum Y^2 - (\sum Y)^2\}}} \quad .(1)$$

Information:

r_{xy} = Koefisien Korelasi

X = Item Score

Y = Total Skor

N = Number of Subjects

Cronbach's Alpha (α) is an internal consistency coefficient that is often used for reliability. Cronbach's Alpha Formula (α) The formula used in this reliability test can be seen as in Formula (2) Cronbach Alpha Formula.

$$\alpha = \left[\frac{k}{k-1}\right]\left[1 - \frac{\sum S_i^2}{S_x^2}\right] \quad (2)$$

Information:

K = Number of question instruments

$\sum S_i^2$ = Number of variances of each instrument

S_x^2 = Variance of the entire instrument

The validity results showed the authenticity of user responses with the condition of r>0.361 and p-value ≤ 0.25, while reliability ensured the consistency of the assessment with a minimum cutt-off condition of >0.70. Feasibility calculations using the ISO 9126 standard measure the quality of software based on the actual and ideal values of each sub-characteristic, which is 25 sub-characteristic. The ISO 9126 model categorizes each software quality characteristic into various sub-characteristics, as shown in Table 2 (Sulandari, 2021).

Table 2 ISO 9126 Standard Sub-Characteristics Table

Indicator	Code	Questions
Suitability	F1	Can the HBIM WebGIS of Selogriyo Temple perform the required functions?
Accurateness	F2	Are the results of data processing on WebGIS HBIM Selogriyo Temple as expected?
Interoperability	F3	Can the HBIM WebGIS interact with other software?
Security	F4	Can the HBIM WebGIS of Selogriyo Temple anticipate / prevent unauthorized access?
Functionality Compliance	F5	Does the HBIM WebGIS of Selogriyo Temple follow the rules of application standards or applicable legal regulations?
Maturity	R1	Is errors implementation WebGIS HBIM on the hardware has been eliminated over time?
Fault Tolerance	R2	Has the HBIM WebGIS of Selogriyo Temple been able to maintain its performance level in case of software and hardware errors?
Recoverability	R3	Can the HBIM WebGIS of Selogriyo Temple recover data if a failure occurs?
Reliability Compliance	R4	Does the HBIM WebGIS of Selogriyo Temple comply with the reliability standards of a software?
Understandability	U1	Can the users of HBIM WebGIS Selogriyo Temple understand how to use it easily?
Learnability	U2	What is steps operational HBIM Selogriyo Temple WebGIS can be learned easily?
Operability	U3	Can the HBIM WebGIS of Selogriyo Temple be used using only limited resources?
Attractiveness	U4	Does the HBIM WebGIS of Selogriyo Temple have an attractive interface?
Usability Compliance	U5	What is HBIM WebGIS of Selogriyo Temple has met the usability standards of a software?

Indicator	Code	Questions
Time Behavior	E1	How fast does the HBIM Selogriyo Temple WebGIS respond to user activity?
Resource Utilization	E2	Can the HBIM WebGIS of Selogriyo Temple utilize resources efficiently?
Efficiency Compliance	E3	Whether the HBIM WebGIS of Selogriyo Temple has met the efficiency standards of a software?
Analyzability	M1	Can errors or identification of modifications to the HBIM Selogriyo Temple WebGIS be easily identified?
Changeabilit y	M2	Can errors that occur in the HBIM WebGIS Selogriyo Temple be repaired easily?
Stability	M3	Whether the HBIM WebGIS of Selogriyo Temple can continue its work function as usual after done changes/improvements?
Testability	M4	Can changes to the HBIM WebGIS of Selogriyo Temple be easily validated?
Adaptability	P1	Can the HBIM WebGIS of Selogriyo Temple be easily transferred to other environments? which is different?
Installability	P2	Can the HBIM Selogriyo Temple WebGIS be installed easily?
Portability Compliance	P3	What is HBIM WebGIS of Selogriyo Temple has complied with the portability standards of a piece of software?
Replaceabilit y	P4	Can the HBIM Selogriyo Temple WebGIS be replaced with other or similar software?

The following is the calculation formula (3) Feasibility Test Score Formula

$$Skor = \frac{Skor\ Aktual\ (f)}{Skor\ Ideal\ (n)} \times 100 \qquad (3)$$

Table 3 Rating Score Scale

Percentage Score	Interpretation
≥ 90	Very good
80 ≤ score < 90	Good
70 ≤ score < 80	Simply
60 ≤ score < 70	Less
Score < 60	Very Less

The real score is determined by the number of answer scores given by the respondent, while the ideal score (n) is the highest score that will be obtained if the respondent chooses the answer with the highest score. After obtaining the calculation results, it is then compared with the conversion scale of the value to determine its classification as very good, good, quite good, poor, or very poor. The conversion scale can be seen in (Jogiyanto, 2008). The conversion scale can be seen in Table 3:

e) Maintenance

In maintenance practice, several things are done including periodically adjusting spatial data by uploading new datasets or updating layers in ArcGIS Online, as well as maintaining 3D model data such as the Selogriyo Temple model to keep it accurate and informative. System performance monitoring is done to ensure there is no downtime or interruption in service by utilizing monitoring tools in ArcGIS Online. In addition, monitoring of applications created with Experience Builder is done to ensure all functions are working properly without bugs. Managing users and access rights is also important to ensure that only authorized users can change system data or configurations, and to set access rights according to user roles.

3. Results and Analysis

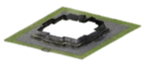
3.1. HBIM 3D Model Segmentation Results

Segmentation is carried out with the aim of dividing parts of the temple based on the components in the temple building. The segmentation process was carried out using Cyclone 3DR and Agisoft Metashape software. This software is used to divide the data point cloud based on the parts of the temple building into 9 parts, namely: the foot of the temple, the temple body, the roof of the temple, the Mahakala Statue, the Nandiswara Statue, the Durga Statue, the Ganesa Statue, the Agastya Statue, and the temple door. The parts of the temple are put together using CityEngine software, in this software also functions to provide information attributes of the parts of the temple that have been divided. To provide more information about the parts of the temple, segments should be performed. Users can understand the meaning of each part of the temple and its reliefs. In this Selogriyo Temple there is no reliefs, but statue as following with Figure 6.

Figure 5 Arrangement of the Segmentation of Temple Buildings

The body of a temple usually consists of three parts: the legs, the roof, and the body. The foot of the temple serves as a representation of bhurloka, or the place where humans live. According to Istanto (2018), the structure of the temple's body symbolizes bhuwarloka, or a world where humans can confront gods or ancestral spirits after achieving purity or perfection. The roof structure of the temple symbolizes the swarloka, or the world where the gods and spirits of ancestors reside. (Istanto, 2018). The following figure shows the arrangement of the series of segmentation of temple buildings. Based on the results of information from one of the employees, Mr. Junawan from BPCB (Cultural Heritage Preservation Center) Central Java said that regarding the Selogriyo Temple Heritage itself, there is no curator, because this is a type of small temple with not many ornaments either. The information obtained regarding the temple building, Selogriyo Temple can be divided in general starting from the roof of the temple, the body of the temple, the foot of the temple, and also the niches of the statues found on the walls of the temple body. Based on information from the cultural heritage restoration employee, Selogriyo Temple can be divided into 9 building parts, which can be seen in the Table 4.

Table 4 Building Segmentation Section

Name	Model	Description
Surface and feet Temple		Area: 78,710 m² Information: Part foot Temple Selogriyo has uniqueness because of the foot temple in the form of sub-temple body basement
Temple Body		Area: 69,922 m² The body of Selogriyo Temple is square in plan with protrusions on each side. The width of the front and side body is 4.20 meters, the height of the body is 2.54 meters, the width of the protrusion is 1.50 meters, and the thickness of the protrusion is 0.30 meters. In this protrusion, there are niches where statues are placed. Niches in Selogriyo Temple five pieces in total
Temple Roof		Area: 81,630 m² The roof of Selogriyo Temple has uniqueness in shape. The roof viewer serves as the base of the roof towers. The roof peak of Selogriyo Temple has been successfully reconstructed (on paper) by de Vink. Based on the reconstruction
Temple Door		Area: 4,523 m² Temple entrance measures 65 cm wide and 170 cm high.
Nandiswara Statue		Area: 2,757 m² Statue Nandiswara is depicted standing and two-handed. The right hand carries a camera, and the left hand holds the left hip. Behind the right hand is a trident. The jewelry worn are a plain chest sash, a necklace, a shoulder band in the form of a cymbal, and a hand bracelet. The temple room (garbhagrha) now contains no objects of worship. On the north side wall of the temple room is a niche measuring 110 cm wide, 150 cm high, and 23 cm deep
Mahakala statue		Area: 2,707 m² This mahakala statue is in a two-handed standing position; the right hand has been broken at the elbow, and the left hand holds the left hip. The jewelry worn includes a belly band (udarabandha), a necklace (hara), and a shoulder band. in the form of a cymbal.
Durga Mahisasuramardhini statue		Area: 2,768m² The Durga statue depicts Mahisasuramardini standing on the back of a mahisa (ox) in a tribangga (slightly twisted waist) position. The statue's head is missing, both earlobes wear shoulder-length kundalas, and the neck is adorned with a necklace. The statue has eight hands; the left hands hold a parashu, kamandalu, snake, and an unidentified object. The top left hand holds the Asura, another hand pulls the Asura, and the bottom hand rests on the abdomen.
Ganesha statue		Area: 2,707 m² The Ganesha statue is depicted with four arms and seated on a padmasana. The head and the two back hands are broken, while the front hands are somewhat intact. One of the surviving

		attributes is a broken tusk held by the front right hand, while the front left hand carries a bowl.
Agastya statue		Area: 2,707 m^2 The Agastya statue is depicted with a kopala crown in the form of a jata makuta. The statue is in a standing position with two hands, adorned with shoulder ornaments in the form of cymbals. Both hands are broken, making it difficult to identify the attributes they carried. One visible attribute is a kamandalu placed on the left shoulder.

3.2. Heritage Building Information (HBIM) WebGIS Results and Analysis

The design is carried out using the Experience Builder application from the ArcGIS Online platform by means of low-code design or no-coding. The author will present the results of the WebGIS interface and interaction design along with its analysis and present the results and analysis of the HBIM WebGIS test results based on the assessment of several users

The author will present the results of WebGIS design and analysis of design elements, navigation, and user interface starting from the Home page, About Selogriyo, Map, 3D HBIM, and About Us pages. HBIM WebGIS can be access with link: https://bit.ly/WebgisCandiSelogriyo.

The home page usually serves as a starting point that introduces users to the website and attracts users' attention, such as presenting key information, navigation to other parts of the site, and providing an attractive visual experience. The design results on the home page can be seen in Figure 7.

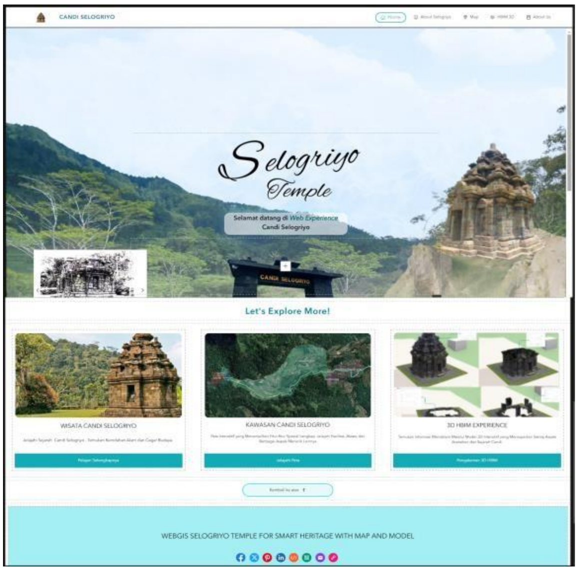


Figure 6 Home page overview

The general structure of the home page navigation will be similar to other pages as in the header section, there are primary navigation menu buttons that link to the 'About Selogriyo', 'Map', 'HBIM 3D', and 'About Us' pages. Secondary navigation is also designed at the bottom of the home page by adding overview images on other pages to give users an idea to explore other pages.

The About Selogriyo page functions as an explanation to add insight to users and also become an attraction for users who have never visited Selogriyo Temple tourism. The display of the page design results can be seen in Figure 8.

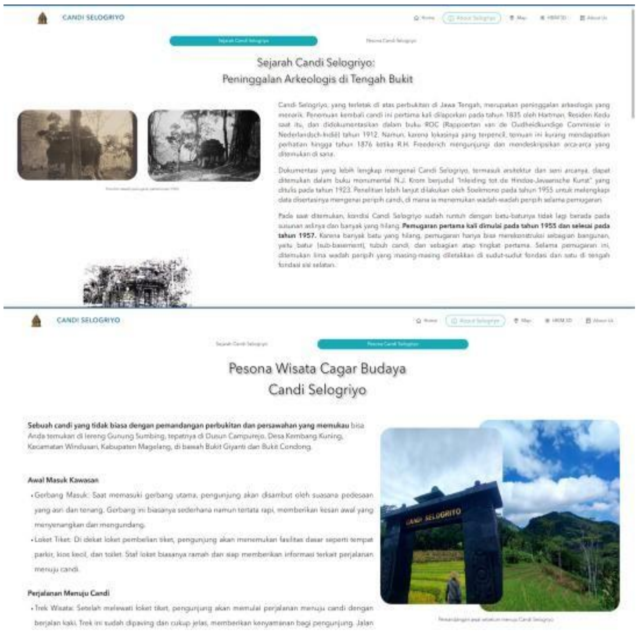


Figure 7 About Selogriyo Page

The designed Selogriyo Temple webpage has two main clear sections: 'History of Selogriyo Temple: An Archaeological Remnant in the Middle of the Hill' and 'The Enchantment of Selogriyo Temple Heritage Tourism'. Both sections contain comprehensive and relevant information about the history and tourist attraction of the temple. The images used support the narrative, providing adequate visual context for the reader.

In terms of content, this webpage successfully conveys information that is in line with its theme. The 'History' section reviews the discovery and archaeological documentation of Selogriyo Temple with formal and informative language, suitable for audiences seeking historical information. The use of subheadings and well-structured paragraphs makes the information easy to understand and does not confuse the reader. Meanwhile, the 'Tourism Charm' section describes the tourist attraction of Selogriyo Temple with interesting and descriptive language, providing a clear picture of the experience that visitors can get. In terms of visual design, this webpage is simple yet effective. Unobtrusive color combinations help readers to stay focused on the main content without excessive visual distractions.

The Map page is one of the main parts of the design of the Selogriyo Temple HBIM WebGIS. This page contains a map view of the Selogriyo Temple area by visualizing starting from the access road, public facilities, and the Selogriyo Temple area zone. The display of the Map page design can be seen in Figure 9.

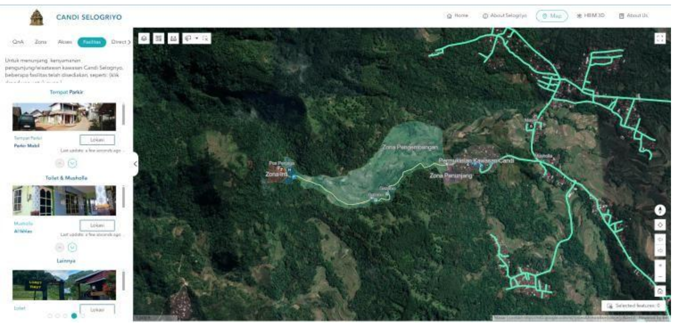


Figure 8 Map of Conservation Page

The Map page is designed by adding several Sections to display interfaces and interactions ranging from 'FAQ', 'Zone', 'Access', 'Facilities', and 'Direction'. The results and analysis of the design of each Section are as follows.

The interface in the FAQ section is designed using a slide dropdown query interaction feature. The content displayed is general information that is likely to be asked if traveling to Selogriyo Temple. Interaction on web users can display information by pressing the button to expand and display answers to existing questions.

The interface in the zone section is intended to display the zoning boundaries of the Selogriyo Temple area based on the Selogriyo Temple Zone Map data from the Central Java Cultural Preservation Center X and BPCB Central Java. The Selogriyo Temple area zone itself is divided into 4 zones, namely: Core Zone, Buffer Zone, Development Zone, and Support and Settlement Zone. The interaction of the interface in the Zone section is displayed using a bookmark query that functions as a bookmark page feature that will display and zoom automatically to the location described. An example of the interaction results and interface of the Zone section is shown in Figure 10.

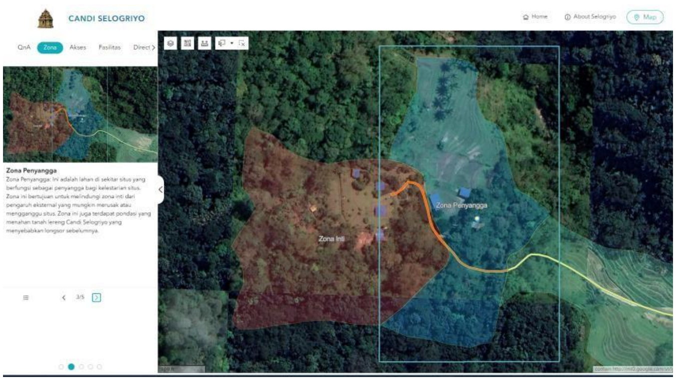


Figure 9 Area Zone Section Interface

In the access section, the interface displayed is content containing how to access the temple area. The interaction that can be done is to query the dropdown button to display road access from vehicles such as cars and motorbikes. The interaction will display a visual on the map to zoom in to the accessible road with a pop-up containing a description of the road along with a photo of the road.

In the public facilities section, the interface displayed is content containing the location of public facilities in the Temple area. Interaction that can be done is to query the dropdown button to display public facilities such as toilets, prayer rooms, rest areas, dining areas, and trash cans. The interaction will display a visual on the map to zoom in to the selected facility, equipped with a pop-up containing a description of the facility along with a photo of the facility. An overview of the interface and interaction results in the Public Facilities section can be seen in Figure 11.

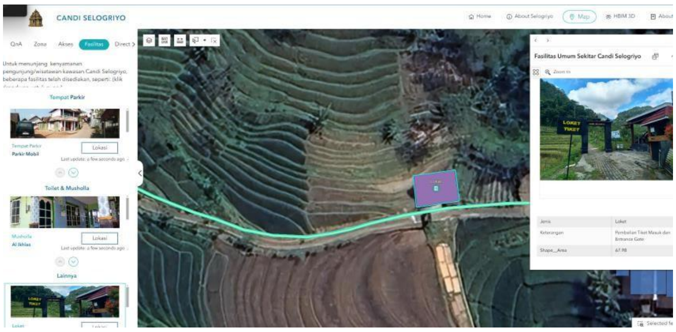


Figure 10 Facility Section Interaction interface

The HBIM 3D page on this WebGIS showcases a three-dimensional model of Selogriyo Temple, featuring interactive widgets. Users can view various parts of the temple, such as the foot, body, roof, and statues, each with detailed information. Key features include an interactive 3D model that allows viewing from various angles, a Bookmark widget that changes according to the selected part of the temple, and a Description Pop-Up providing detailed information upon clicking a section. Additionally, the Model Layer feature enables users to toggle sections on and off for specific details, while the Full-Screen feature offers an immersive view of the 3D model. Users can also take measurements for accurate dimensional information. Analysis of this interface highlights its necessity for providing visitors and researchers with an in-depth understanding and visually appealing representation of Selogriyo Temple. The detailed information on each part of the temple enhances knowledge of its history and architecture. From a user experience perspective, the interface is interactive and intuitive, making exploration easy, and user feedback is crucial for further improvements. Technically, the 3D model loads quickly, and interactions such as rotation and measurement run smoothly, thanks to HBIM technology, which ensures an accurate and informative 3D representation of the temple. An example of the interaction results and interface of the 3D HBIM interface is shown in Figure 12.

Figure 11 3D HBIM Page Interface

Figure 13 Simulation of Compatibility of Multiple Device and System Types Operation

3.3. Heritage Building Information (HBIM) WebGIS Results and Analysis

Testing was carried out in two stages: compatibility test and website testing based on ISO 9126 standards.

The compatibility test process is carried out using the Sorsite site to check directly for each aspect such as the device / OS and browser used as follows, can be seen in Figure 13.

This tab shows pages that exhibit browser-specific behavior, or trigger browser b

Browser	Edge	Firefox	Safari	Opera	Chrome	iOS		Android
Version	124	124	17	109	124	≤ 16	17	120
Critical Issues	✓	✓	✓	✓	✓	✓	✓	✓
Major Issues	✓	✓	✓	✓	✓	✓	✓	✓
Minor Issues	✓	✓	✓	✓	✓	✓	✓	✓

Figure 12 Compatibility Test Results from SortSite

The HBIM WebGIS application underwent compatibility testing using the SortSite platform across various browsers (Edge, Firefox, Safari, Opera, Chrome) and devices (iOS and Android). The test aimed to ensure the application's functionality in diverse environments. Results showed no critical, major, or minor issues on all tested platforms. The absence of critical issues confirms the application's stable and reliable essential functions, while the lack of major issues indicates a consistent user experience. The absence of minor issues suggests that the application is well-optimized for smooth operation across multiple platforms. Despite good performance in compatibility tests, real-world use revealed issues on smartphones and laptops with varying screen sizes. Users reported clipped text, less visible features, and lag on smartphones, likely due to screen resolution variations and hardware limitations. Laptops experienced visual constraints, such as truncated views, indicating a need for better responsive display customization and further testing across different screen resolutions.

While the HBIM WebGIS application showed excellent compatibility with no major issues during testing, these real-world problems highlight the need for improved optimization and display adjustments to enhance user experience across diverse devices.

Tests using the ISO 9126 standard using the results of usage tests by several users using 25 questions based on the number of ISO 9126 sub-characteristics. The user needs questionnaire that was distributed was successfully filled out by 32 respondents from various regions.

The validity test is used to determine how valid the questions or statements given to respondents are with the aim of revealing something. Validity is needed to state the suitability of the measurement results. Validity is calculated using the product moment correlation technique. The method connects the total score of each respondent with each variable. The results of the validity test calculation can be seen as in Table 5.

Table 5 Validity Test Calculation Results

Item	Correlation(r)	P_Value	Cut-off	Validity
F1	0,86492	1.73E-10		Valid
F2	0,84518	1.16E-09		Valid
F3	0,97434	5.49E-21		Valid
F4	0,97434	5.49E-21		Valid
F5	0,97434	5.49E-21		Valid
R1	0,61172	1.99E-04		Valid
R2	0,44577	1.06E-02		Valid
R3	0,97434	5.49E-21		Valid
R4	0,73352	1.79E-06		Valid
U1	0,58772	4.05E-04		Valid
U2	0,90082	2.15E-12	r >0,3	Valid
U3	0,97434	5.49E-21		Valid
U4	0,97434	5.49E-21	p_value	Valid
U5	0,97434	5.49E-21	<0,025	Valid
E1	0,97434	5.49E-21		Valid
E2	0,53933	1.45E-03		Valid
E3	0,97434	5.49E-21		Valid
M1	0,52027	2.27E-03		Valid
M2	0,58772	4.05E-04		Valid
M3	0,97434	5.49E-21		Valid
M4	0,86383	1.93E-10		Valid
P1	0,97434	5.49E-21		Valid
P2	0,48153	5.26E-03		Valid
P3	0,40712	2.07E-02		Valid
P4	0,57818	5.28E-04		Valid

The validity test results obtained a number of values for each question. In this study the authors took a "cut off" or a value that stated the conditions validity for us to analyze. The first requirement for a hypothesis that can be tested includes: (1) H0: ρi = 0 (there is no correlation between the score of the i-th question item and the total score of its dimension); (2) H1: ρi 0 (there is a correlation between the score of the i-th question item and the total score of its dimension). The test criteria used are (H1: ρi 0) or (H0 rejected) if (ρ- value ≤ α/2). If the alpha (α) value is 0,5, then if there is a value (p-value ≤ 0,025) there is a significant correlation. The second requirement is if the r-value is (≥ 0,361). If these two conditions are met, the answers to the questions the author asks are proven valid. Overall, the questions submitted to users are valid for each question, this is evident from the "cut off" value or the validation requirements are met.

Reliability test is needed to state that the answers obtained are consistent (reliable). The calculation used is Cronbach's Alpha (α). This calculation is an internal consistency coefficient that is often used for reliability. This test is slightly different from the validation test, because this test states that all questions can be summarized as reliable or not, while the validation test states per part of the questionnaire question. The results of the reliability test can be seen in Figure .

```
> # Menampilkan hasil
> print(cronbach_alpha)

Reliability analysis
Call: alpha(x = data)

  raw_alpha std.alpha G6(smc) average_r S/N    ase mean   sd median_r
      0.97      0.97    0.96       0.6  38 0.0062    4 0.58     0.49

    95% confidence boundaries
         lower alpha upper
Feldt     0.96  0.97  0.99
Duhachek  0.96  0.97  0.99
```

Figure 14 Cronbach Alpha Reliability Results

```
> # Menampilkan interpretasi
> cat("Cronbach's Alpha: ", nilai_alpha, "\n")
Cronbach's Alpha:  0.9748851
> cat("Interpretasi: ", interpretasi, "\n")
Interpretasi:  Sangat Baik
```

Figure 15 Interpretation Results

The reliability test results obtained the Cronbach Alpha (α) value above the requirements that have been determined by the "Cut-off" value, namely (≥ 0,7). The greater the value obtained, the better (consistent) the measurement. But sometimes in certain cases, if the value is too high, there may be aspects with the same variable repeatedly asked. So that the narrower coverage decreases the value of the content. When there are many questions, the score can also increase, but it does not necessarily mean that the research is of high quality. Careful consideration of research questions is needed, therefore there is a requirement for a "cut-off" value of (≥ 0,7) to maintain consistency (reliability). The Cronbach's Alpha value of 0,97 indicates a high level of consistency in the measurement of the variables studied, in accordance with the ISO 9126 standard for software testing. Of the 32 respondents involved, the majority were students (90,6%) with the rest being civil servants (9,4%). Although the sample size was relatively small, the diversity in the respondents' job types provided enough variation for reliability analysis. This adds to the internal validity of the questionnaire, indicating that this instrument can be relied upon to support research findings with good quality.

The reliability test results obtained using the ISO 9126 standard. ISO 9126 is an international standard for software quality evaluation, which includes six main characteristics: Functionality (F), Reliability (R), Usability (U), Efficiency (E), Maintainability (M), and Portability (P). The results of this feasibility test are shown in Table 6.

Table 6 Results of ISO 9126 Feasibility Test Assessment

No.	Variables	Actual Value	Ideal Value	Score (%)
1	F	645	800	80,625
2	R	509	640	79,53125
3	U	650	800	81,25
4	E	379	480	78,95833
5	M	509	640	79,53125
6	P	530	640	82,8125

Based on the results displayed in the table above, it can be concluded that the system as a whole has a good level of feasibility. The values for each variable show percentages close to or exceeding 80%, which is generally considered the limit of adequate feasibility.

a) Functionality (F): With a score of 80.625%, the system demonstrates adequate functional capabilities according to user needs and expectations. This means that the features in the system are complete enough and fit the desired purpose.
b) Reliability (R): A score of 79.53125% indicates that the system has a reliability level that is almost close to ideal. This means that the system is quite stable and has a low failure rate in its operation.
c) Usability (U): With a score of 81.25%, the ease of use aspect of the system was rated as excellent. This indicates that the interface and user experience have been well designed to make it easier for users to interact with the system.
d) Efficiency (E): A score of 78.95833% for efficiency indicates that the system is already quite efficient in resource usage. Although the value is slightly lower than other variables, it is still within acceptable limits.
e) Maintainability (M): A score of 79.53125% indicates that the system is easy to maintain and repair. This means that necessary changes or improvements can be made easily without disrupting the overall performance of the system.
f) Portability (P): With a score of 82.8125%, the portability aspect of the system is rated as excellent. This means that the system can be easily moved and run

on a variety of different environments or platforms without requiring significant modifications.

Overall, the results of this feasibility test show that the system has a fairly good quality in accordance with ISO 9126 standards, with the score of each variable approaching or even exceeding 80%. This shows that the system is feasible to use and can meet user needs well.

4. Conclusion

The 3D HBIM model of Selogriyo Temple was developed through segmentation using Cyclone 3DR and Agisoft Metashape software, dividing the temple into nine main parts: temple foot, body, roof, and various statues. CityEngine software unified these segments and assigned attributes, enhancing the understanding of each part's meaning and function. Mr. Junawan from BPCB Central Java highlighted the temple's simplicity yet detailed segmentation, aiding digital preservation and education.

The WebGIS and HBIM design, following the Waterfall Method and using ArcGIS Online's Experience Builder, resulted in an efficient, user-friendly interface. The interactive Home, About Selogriyo, Map, and HBIM 3D pages provided comprehensive information and navigation, ensuring a satisfying user experience.

Usage, validity, and reliability tests of the WebGIS Map and HBIM showed high feasibility. The validity test confirmed all items were valid, and the reliability test yielded a Cronbach's Alpha of 0.97, indicating high consistency. ISO 9126 standard feasibility testing scored variables close to or above 80%, demonstrating the system's quality, user satisfaction, and suitability for managing and disseminating information about Selogriyo Temple..

5. Statement of Conflict of Interest

The authors declare no competing interest.

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