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The development of WebGIS for the cultural sites in Kotagede Sub-District combined with 360° photosphere visualization

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Abstract. Kotagede is one of sub-districts in the Special Region of Yogyakarta which has several potentials especially in the cultural tourism industry. Long time ago, it was being the capital of Mataram Islam Kingdom. As a center of The Kingdom, Kotagede becomes one of the most important historical tourist spots in Yogyakarta. It is also a heritage city with great potentials to support the prosperity of its residents. The cultural site in Kotagede could be presented in the form of web based Geographical Information System (GIS) related to the spatial aspects, also by combining with 360° photosphere as its dynamic visualization. This WebGIS was made by integrating Google Camera, ArcGIS Online, ArcGIS Desktop, Pannellum website, and Clouldinary website. Usability testing was conducted with the System Usability Scale (SUS) as the testing instrument. Cultural site information in the WebGIS can be displayed in the form of an online map included widgets and other various functions in order to make it easier to be explored.

1. Introduction

Kotagede is one of the sub-district in the Special Region of Yogyakarta that has the potential in the cultural tourism industry. This is because Kotagede was an old city, and it was the capital of Mataram Islam Kingdom which held many cultural objects and buildings. As the center of Mataram Islam Kingdom, Kotagede becomes one of the most important historical tourist spots in Yogyakarta. It is also a heritage city with great potentials to support the prosperity of its residents [1]. Other than becoming a tourist site in Yogyakarta, Kotagede is also known for its silver craft and historical values related to Kraton Kasunanan Yogyakarta [2]. The cultural site in Kotagede can be displayed in the form of Geographical Information System (GIS) related to spatial aspect, also by making use of 360° photosphere dynamic visual technology. The use of spherical images for representation of architectural and archaeological objects have shown great interest and recently received increasing attention. The advantage of using spherical images is the low cost of the equipment used for acquisition [3]. The use of 360° photosphere is to help user knows the condition and environment around the cultural site and to attract the tourists to visit this site. With the web-based Geographical Information System, the information displayed has spatial aspect metadata. Beside of that, utilizing 360° photosphere in a web-based Geographical Information System could be an alternative to display the information about that area. It is advantageous to use spherical image to display information related to cultural sites because they allow natural and easy control of the viewing space, display an intuitive and minimalist user interfaces, and cross-platform support across a range of hardware and displays software so that will make it easier for webGIS users [4].

The activity scope of making WebGIS about Kotagede is, this WebGIS displays the location distribution of Mataram Islam cultural, information about its history also a dynamic visual display using the 360° photosphere around the cultural heritage site. Shapefile data is processed using ArcGIS Desktop and



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ArcGIS Pro integrated with ArcGIS online, in the making of this WebGIS, a few information about the area around the site was added so that the users can do a query, like showing the shortest route and showing the nearest cultural site. The goal of making this WebGIS is to serve and display geospatial information about Mataram Islam cultural site in Kotagede in an internet-accessible website also with a 360° photosphere.

2. Methodology

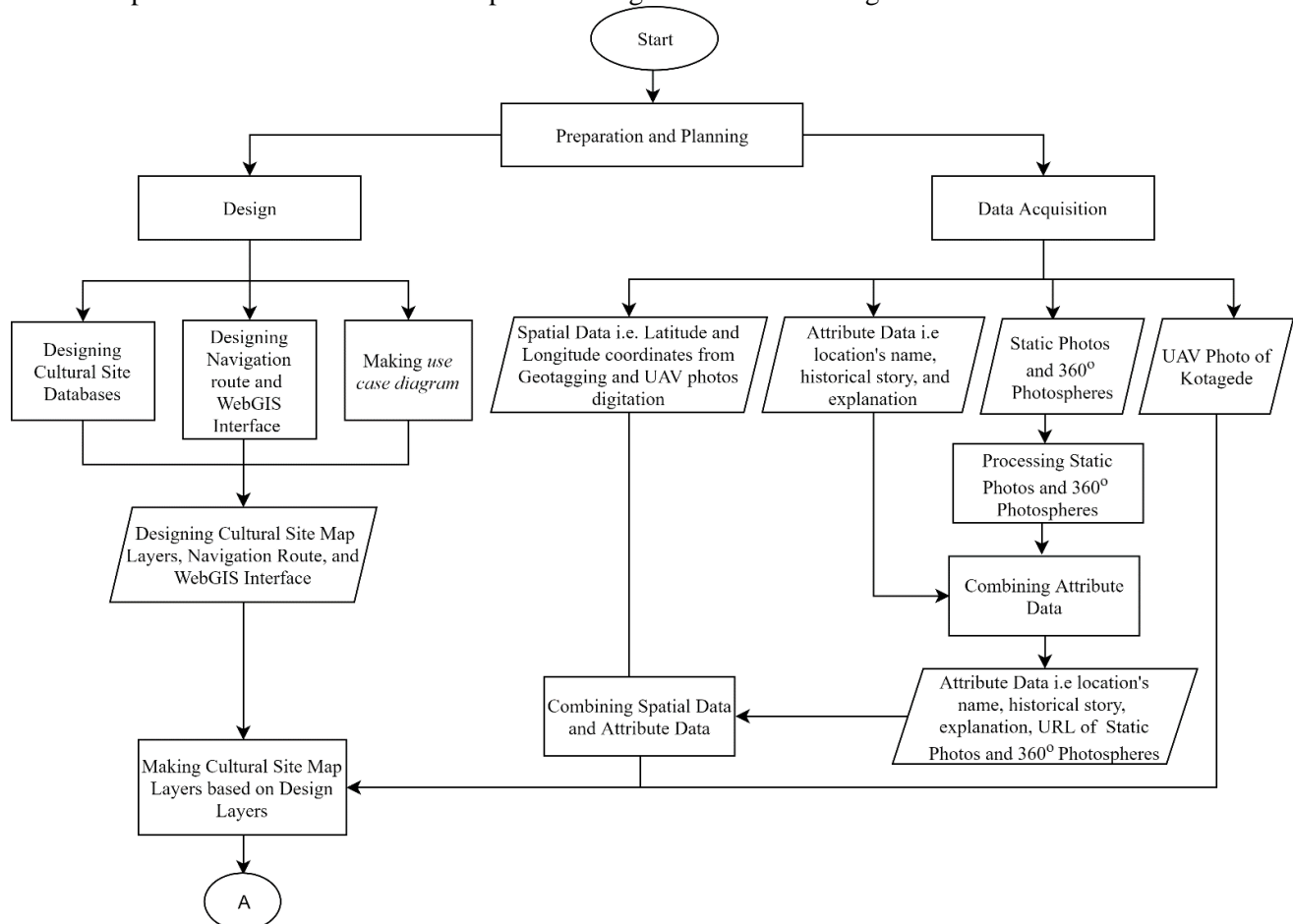
2.1. Material

Material used in this applicative activity covers spatial data and attribute data that consist of:

- UAV photo of Katagede, that was already georeferenced, used as the base layer. Kotagede UAV photo in *.ECW format, taken in 2018 using Skywalker drone and DJI Phantom 3 Pro with GCP point measured with static net method Geodetic GPS with Boulevard UGM's tie point.
- Static photos and photospheres around the cultural site with geotagging included, taken between February-April 2019.
- Attribute data in the form of historical information for each block in Mataram Islam Kingdom, obtained from literature study and interview with the court retainers that stationed around the tombs of Mataram Kings.

2.2. Method

The implementation of this work is explained using the flowchart in Figure 1.



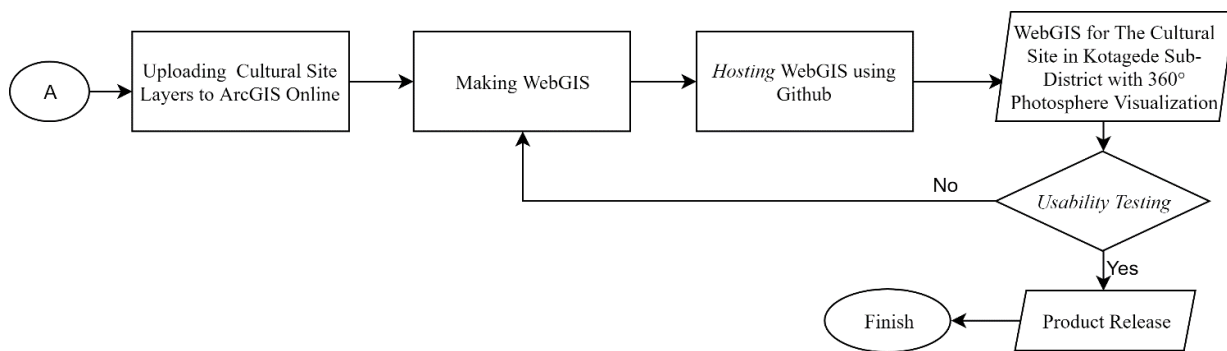


Figure 1. Flowchart

2.2.1. Data Gathering

WebGIS of Kotagede cultural site uses attribute text data obtained from literature study and interview with Abdi Dalem (court retainers) stationed around the Mataram Kings' tombs. A 360° photosphere and static photo are captured using Google Camera Apps. Coordinate spatial data from the cultural site location are obtained by using geotagging when capturing 360° photosphere.

2.2.2. 360° Photosphere Processing

360° photospheres were processed using Panellum website and hosted using Cloudinary to obtain the URL. To display the 360° photospheres, we need to pay attention to the pixel size of the photo. To be able to be displayed on a smartphone, the size must not exceed 4096 px.

2.2.3. Cultural Site Data Compiling

Kotagede cultural site's data are compiled using Microsoft Excel software. Spatial and attribute data are integrated and processed in the software, forming layers. The data displayed inside the tables were : the location name, the history and the function of the building, Latitude and Longitude coordinates, and URL link of the static and photosphere.

2.2.4. Making and Uploading Map Layers

The data displayed inside the tables were, the location's name, its history and the function of the building, Latitude and Longitude coordinates, and URL link of the static and photosphere. The table was saved in *.csv format. The file was then processed using ArcMap-ArcGIS Desktop using ArcGIS Pro and then exported as shapefile. All layers were uploaded to ArcGIS Online Universitas Gadjah Mada. ArcGIS Online provides access to ESRI Server, so that user can manage, develop, and save information in the form of data layers [5].

2.2.5. Making Symbol Design, Use Case Diagram, and Web Interface

Use Case Diagram was utilized during the development of Geographic Information System for Kotagede cultural site. The development of the diagram involves information users with the Web developers. Well designed user interfaces plays an important role for improve the performance and appeal of the Web, helping to convert "tourists" or "browsers" to "residents" and "customers" [6]. The design of the symbols for Kotagede cultural site refers to cartography rules and should represent the object to make it easier for the users to understand. The web interface design is divided into two parts i.e. the main page and the home page.

2.2.6. Making WebGIS

The WebGIS development process could be conducted using three available options provided by ArcGIS Online, using a Template, using the Web App builder, and using Operation Dashboard. In this stage, the writer used the template provided by Web App builder for ArcGIS.

2.2.7. Customizing Web Widgets

Customizing process for the web widgets was done directly on Web Appbuilder for ArcGIS. There are many widgets and menu buttons that could be utilized for finding information related to the cultural site.

2.2.8. Hosting Web using Github

Before hosting the project onto the GitHub, download the webmapping that was already created by the user in ArcGIS Online. The website was uploaded using GitHub Pages, the user will obtain the website URL address with Github.io as a sub-domain address.

2.2.9. Usability Testing

The usability testing in this project was conducted using System Usability Scale (SUS). This SUS testing uses 10 statements as a testing method. Each statement has a 1 to 5 scale. Scale 1 indicates discrepancy while scale 5 indicates conformity. SUS testing on Kotagede cultural site information system used 15 testing samples. The respondents were chosen randomly and were expected to include all user element to give advice and critics to develop the website and make it more useful and efficient.

3. Result and Discussion

3.1. Cultural Site Data Compilation

Kotagede cultural site data is compiled using Microsoft Excel. Data displayed in the table are the name of the location, history, the function of the building, latitude and longitude coordinate, and the URL of the static and 360° photosphere.

3.2. Cultural Site Layers

This WebGIS produces 5 layers, 360° photospherelayers, building layers, fort layers, Mataram Kings' tomb layers, Kotagede Mataram mosque and one extra layer which is Kotagede UAV photo layers, every layer in web has a visualization that was designed using cartography rule. Every layer mentioned were shown as a symbol feature in the form of points in the map layer. The layer display in a smartphone was arranged and adjusted according to each symbol, as shown as Figure 2.

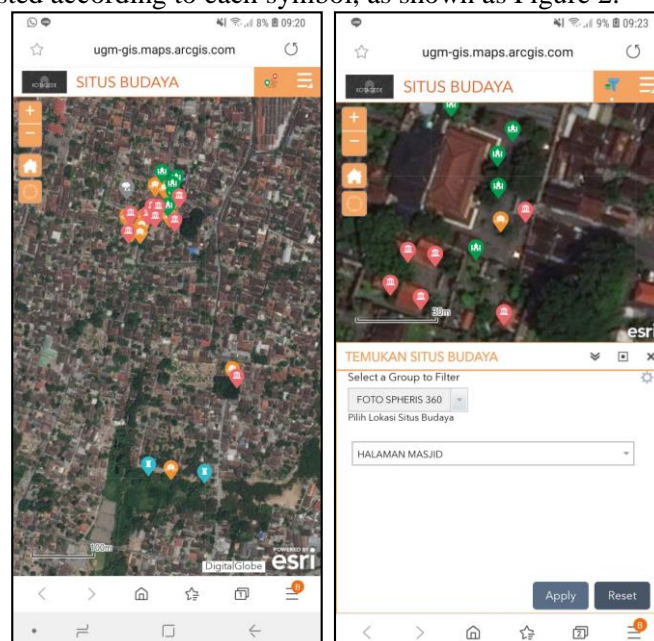


Figure 2. Layers Display

3.3. 360° Photosphere

The 360° photospheres are obtained from direct survey in the location and captured using Google Camera application. Generally 360° photo was similar to a panorama photo, but the view of 360° photo

is not only covers horizontal plane but also covers every angle. Here is an example of 360° photo for the main area of the mosque, shown in Figure 3.

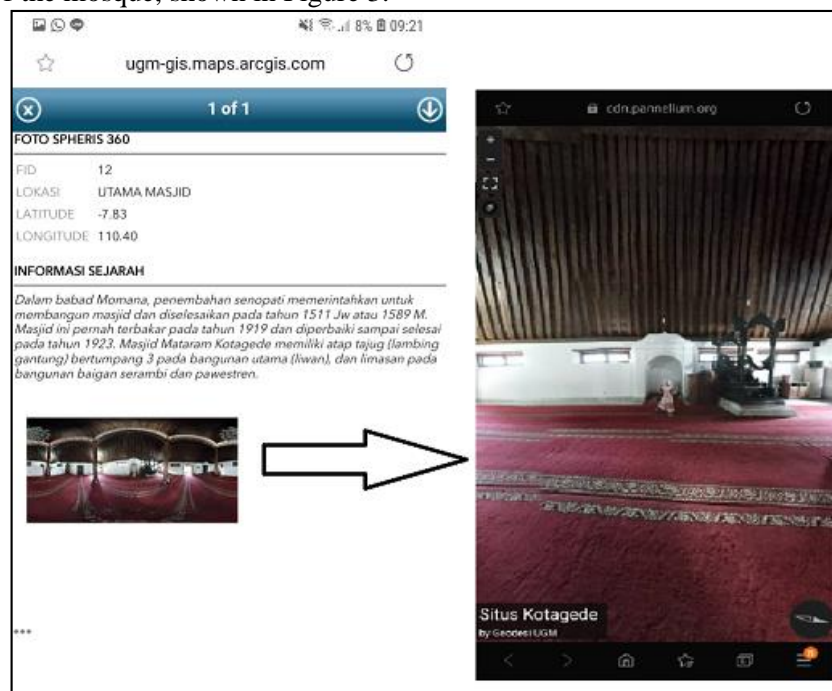


Figure 3. 360° Photosphere

3.4. Web Interface

To access webGIS, users only need to enter a web address (URL). The advantage of this WebGIS was that users can use any browser that supports WebGIS display so users don't need to install the application. This provides the advantage that Webgis can be opened on a desktop or smartphone. However, to be displayed on a desktop or smartphone, certain settings were needed because browsing large web pages which was not adapted for small-screen viewing was still very inconvenient [7]. In this information system, the web interface is divided into two parts, the main display, and the homepage. The homepage contains greetings and simple guide for using the WebGIS. While the main page contains an interactive online map with Imagery Basemap that contains information related to the cultural site including the function buttons. The buttons in this WebGIS are zoom in and zoom out buttons for the map, search button, filter button, near me button, direction button, info button, legends button and layer button. The interface of the homepage and the main page are shown in Figure 4.

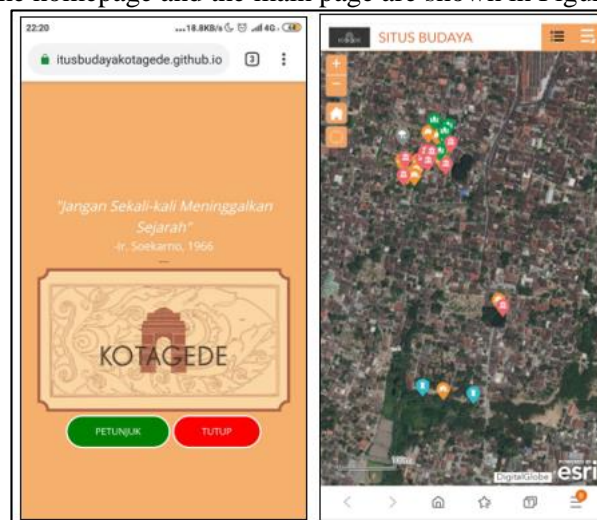


Figure 4. Web Interface Display

3.5. Scenario Can Be Down Using Web

The making of the WebGIS in this applicative work was done to make it easier for people to find information related to Kotagede cultural site. To do so, users have to go through a few steps, opening the browser, entering the WebGIS web address, closing the homepage interface, and then finding information related to a cultural site with the dropdown menu in the widget group filter, like as shown in Figure 5. Moreover then heading to the cultural site location using the direction widget, as shown in Figure 6.

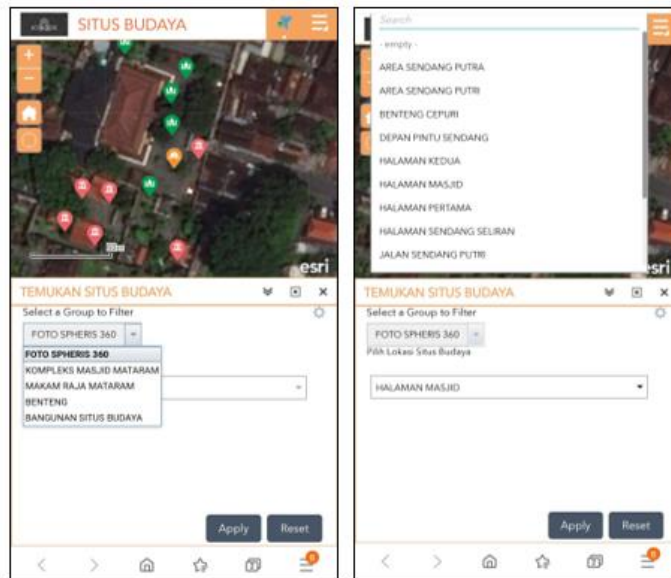


Figure 5. Dropdown widget Group filter

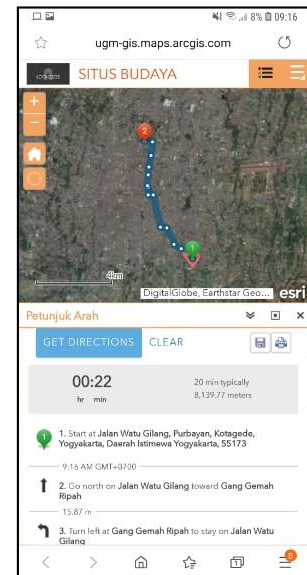


Figure 6. Direction from UGM to ablution place of Mataram; Kotagede Mosque complex.

Besides that, users can find the nearest cultural site by utilizing the Near Me widget. User has to define the initial location as a reference and the distance of the cultural site that the user wants to find. The referenced locations are the locations that are provided by the cultural site layers. The utilization of Near Me widget is shown in Figure 7.

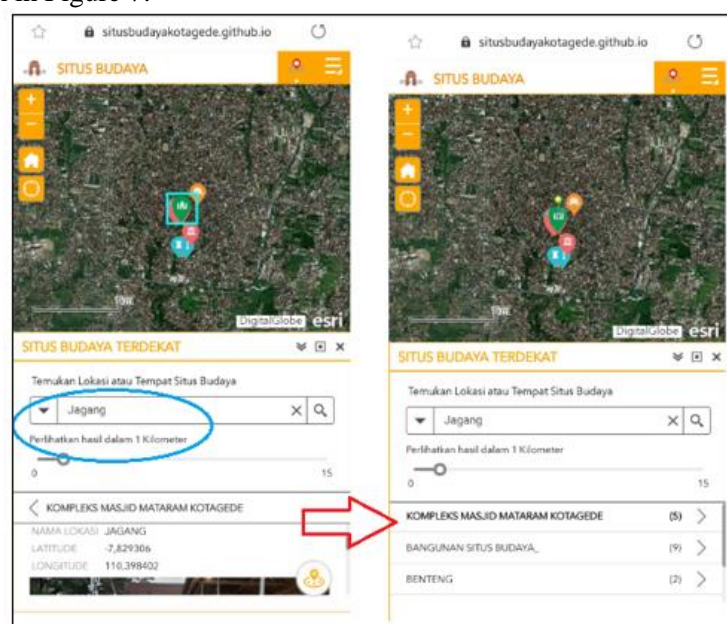


Figure 7. Display the nearest cultural site within 1 Km of Jagang

3.6. Usability Testing Result

Usability testing with system usability scale instrument, can minimize the cost for testing, because it does not require a large number of samples [8]. Martoyo and Falahah mentioned that the testing focus using SUS instrument is to assess the software interface interaction with an evaluator in which the end-user candidate is determined by the sample in the society [9]. SUS testing was done on the Kota Gede cultural site information system using 15 testing samples. This was intended to find out responses and suggestions from potential users, namely the general publics. The following are the result of scoring for each respondent shown in table 1. The result of usability testing reached a value of 89, which means this information system is feasible for public and general use.

Table 1. Usability testing assessment results with 15 respondents

Respondent	Assessment Result	Score
1	36x2.5	90
2	30x2.5	75
3	34x2.5	85
4	40x2.5	100
5	38x2.5	95
6	22x2.5	55
7	28x2.5	70
8	32x2.5	80
9	29x2.5	72.5
10	35x2.5	87.5
11	29x2.5	72.5
12	31x2.5	77.5
13	25x2.5	62.5
14	33x2.5	82.5
15	32x2.5	80
Average		79

4. Conclusion

Based on the activities that have been carried out during the implementation of this applicative activity, we can make a few conclusions, this activity produced a webgis that was created using ArcGIS Pro, ArcGIS Online, ArcGIS Geoportal Universitas Gadjah Mada, and Web AppBuilder also HTML 5 and JavaScript, this webgis contains information about Mataram Islam Kingdom cultural site in Kotagede by utilizing 360o photo, and based on the result of usability testing with System Usability Scale with 15 respondents, this information system as a whole is feasible to use, and would help and provide people with information and knowledge regarding to the cultural site.

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