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Geographic Information System for Student Distribution Area Mapping

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Abstract

Determining MTs Muhammadiyah Metro school's promotion location is often constrained because it has difficulty digging up information on the student's distribution. One of the reasons schools find it difficult to dig up student distribution information is that there is no digital mapping, so that isn't easy to carry out promotion in the right location. This study aims to develop a geographic information system for students' areas visualizing distribution maps. System development is carried out by applying the prototype method. The results showed that GIS could help schools determine students' distribution based on markers with different colors. The GIS test uses the ISO 25010 software testing quality standard consisting of eight aspects and the black-box method to examine system functionality. ISO 25010 testing obtained a value of 86.75%, which, based on the interpretation criteria range, is very feasible. The black-box test result show that the system can function properly as evidenced by a righteousness rate of 100%

Keywords: Geographic information system; Prototype; School promotion; Student distribution area

1. Introduction

School promotion is an educational service marketing activity that will develop an educational institution to be bigger (Khasanah, 2015; Margareta et al., 2018). Promotional activities from school will provide information that can influence students interested in registering at their school (Kasmad et al., 2020). One of the obstacles faced by the Madrasah Tsanawiyah (MTs) Muhammadiyah Metro school is the determination of the promotion location because the school has difficulty digging up information on the distribution of students. MTs Muhammadiyah Metro is a private junior secondary education school with a distinctive religious education having its address at Imopuro, Central Metro, Metro City, Lampung.

Student distribution information is essential to determine the priority scale of the promotion location. The fewer the student's number in an area close to the school, it is a top priority to increase promotion in that area (Surianto et al., 2018). One of the reasons for schools' difficulty in extracting information on student distribution is that no student's digital mapping or student origins are only listed in spreadsheet data. This means that the data has not been processed in a digital map, so that it is difficult for the school to see the student's distribution to determine the exact promotion location.

The development of information technology is so fast nowadays that the use of information technology is increasing. With the development of information technology, many studies have been carried out to encourage the emergence of new discoveries in the technical field. One such invention is the Geographical Information System (GIS). GIS is a computer-based system used to store, process, and analyze geographic information (Kurniasih & Setiyadi, 2019). GIS can make it easier to map areas digitally. Digital mapping is a representation of geographic phenomena that is stored for display and analysis by a computer (Nurkholis et al., 2022). Each object on a digital map is stored as one or a set of coordinates (Hamzehpour et al., 2019).

Previous research has examined GIS to support tourism promotion at the Department of Tourism and Culture of Malang Regency (Putra et al., 2019). The research shows that the system can help the community explore tourism information so that it can be used as a promotional medium. GIS can also facilitate public services mapping, such as in the distribution of public facilities (Mushonga et al., 2017; Taki & Lubis, 2017; Wang, 2020), mapping of natural disaster areas (Farhan &

Akhyar, 2017; Sari & Innaqa, 2017), mapping health clinics (Rini & Aprianto, 2019; Singh, 2018), mapping workshops (Hermawan, 2020), mapping agricultural commodities (Sitanggang et al., 2017), and exploring potential natural resources of a region (Alita et al., 2020; Sitanggang et al., 2020; Yanto, 2019). Based on this, the mapping of the distribution of student areas at MTs Muhammadiyah Metro is expected to help find out information on student coordinates so that promotion can increase and meet targets to develop schools.

This study aims to build a geographic information system as a medium for mapping student areas' distribution, with a case study of MTs Muhammadiyah Metro. The information is presented visually in a map and packaged in a geospatial-based student information system. GIS is expected to help schools to search for information on student areas easily. Besides, promotion is right on target to the community to attract students' interest to participate in raising schools. The student distribution information used is for the 2018-2020 period to provide online mapping and be used for school promotion in the following year.

2. Methodology

The case study in this research is MTs Muhammadiyah Metro, Metro City, Lampung Province, which requires applying a special solution to see the range of student area distribution points for school promotion. In system development, this research uses the prototype method. Using the prototype method is good to use when the client cannot provide user functional requirements maximally (Syahriani et al., 2021). In general, this research consists of six stages, shown in Figure 1.

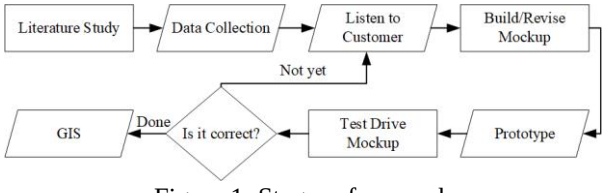

Figure 1. Stages of research

The research stage is a research activity carried out in a planned, orderly, and systematic manner to achieve certain goals. Based on Figure 1, here is the explanation.

A) Literature Study

Based on the literature study, this study adopts the use of web-based. The difference in this study from the previous research is that the development method used is a prototype and focuses on mapping the distribution of students' areas to dig up information to carry out school promotions.

B) Data Collection

At this stage, data collection on user requirements was carried out to be applied to the GIS for Web-Based Student Area Distribution Mapping at MTs Muhammadiyah Metro. The data collection methods used in this study are:

1) Interview

The interview was aimed at the headmaster as the person in charge who knew the school's obstacles in mapping the distribution of student data. Also, resources are provided and utilized optimally to achieve goals effectively and efficiently.

2) Observation

Observations were made at MTs Muhammadiyah Metro to determine the required data retrieval, such as student data, to determine the coordinate points' location. Observe the school in student data management using Microsoft Excel to know the student data's lack of detailed location attributes.

3) Documentation

Documentation is done by archiving data related to research and taking photos in applying the GIS for Mapping the Distribution of Student Areas at MTs Muhammadiyah Metro.

C) Listen to Customer

All user requirements are summarized into useful information to build an application following the application's purpose. Analyzing system requirements is carried out using PIECES (Performance, Information, Economic, Control, Efficiency, and Service), such as functional and non-functional requirements analysis. PIECES is a method for gathering and handling problems in service quality (Iswardani et al., 2018). Analysis of functional requirements requires what processes/services the system must provide, including how the system reacts to certain inputs and how they behave in certain situations. The non-functional analysis is a requirement that focuses on the behavioral properties of the system. The analysis obtained is the result of data collected from previous interviews with the headmaster of MTs Muhammadiyah Metro.

D) Build/Revise Mockup

The design and coding of the proposed system are carried out, including designing

functions in the system, designing Unified Modeling Language (UML) diagrams, designing interfaces, and coding the designs that have been defined. The system design is in the form of the geographic information system mock-up for mapping the area distribution of MTs Muhammadiyah Metro students. In object-oriented programming, UML is a standard language that is extensively used in the corporate sector to create requirements, perform analysis and design, and describe architecture (Syahriani et al., 2021). This study uses three UML diagrams, namely use case diagram, class diagram, and sequence diagram. The following is a use case diagram based on the functional requirements analysis that has been carried out in Figure 2.

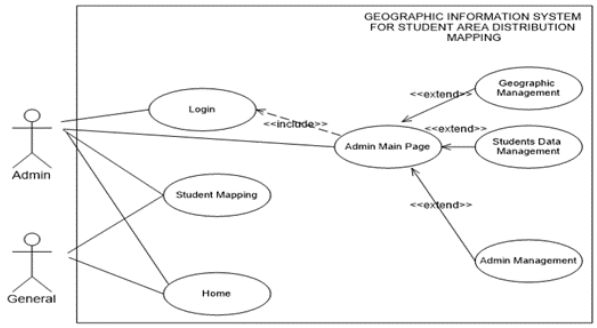

Figure 2. Use case diagram

In Figure 2, it can be seen that there are two actors involved in the GIS being developed, namely admin and public. Each actor has a different role, where the admin can access all functions, while the public can only access the main page, information, and registration. Next, design a class diagram resulting from the analysis carried out to know the description and visualization of the class structure in GIS, shown in Figure 3.

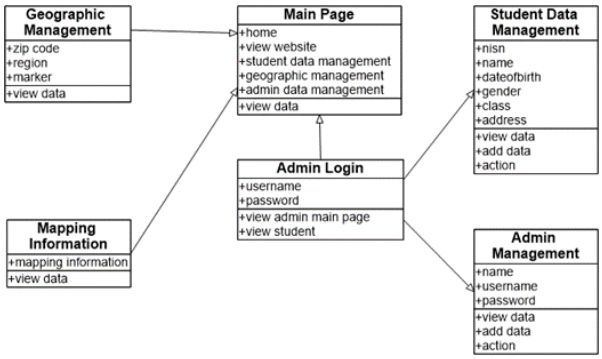

Figure 3. Class diagram

Based on Figure 3, there are six classes used to develop a GIS database architecture. These classes have attributes, relationships, and operations based on the functions in the use case diagram. Furthermore, a sequence diagram is designed to describe objects' interaction in a system or business process. The following is an overview of the GIS Sequence Diagram in Figure 4.

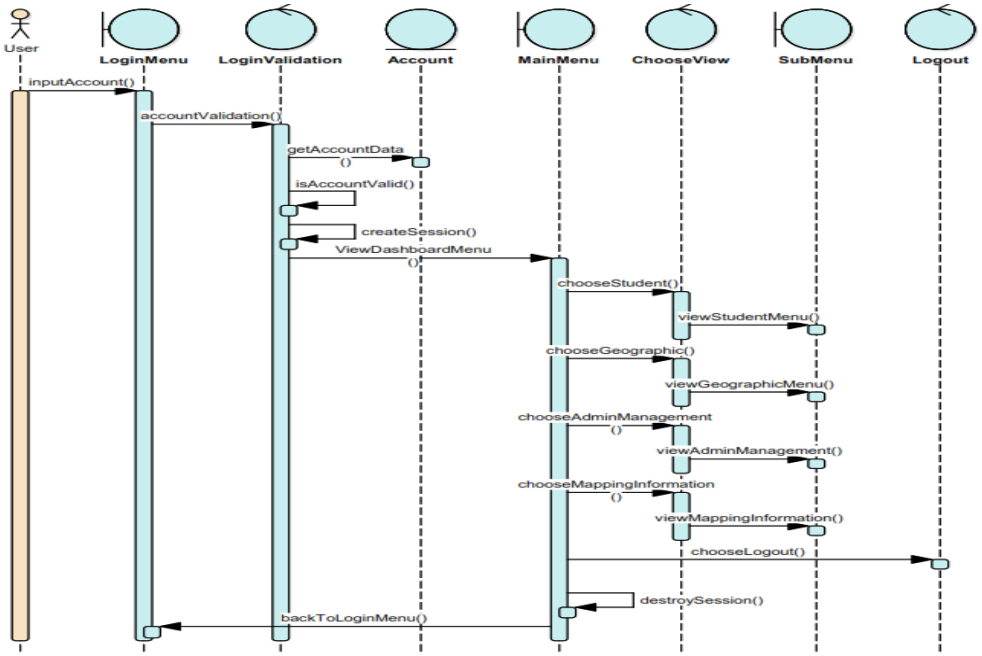

Figure 4. Sequence diagram

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Figure 4 shows the object interactions arranged in a time sequence. It also describes the objects involved in the scenario and the order of messages between objects needed to carry out the scenario functionality. In general, the GIS architecture to be developed is shown in Figure 5.

Figure 5. GIS architecture

According to Figure 5, web-based system development is carried out using the PHP programming language. Also, components needed to build this system include the MySQL database, bootstrap framework, and google maps API. The following is an explanation of each of these components.

1) PHP programming as the backend framework to integrate database and the user interface
2) MySQL database as the storage for data used, such as spatial (longitude and latitude) and non-spatial data (name, nisn, etc.).
3) Bootstrap framework as the front end to provide web-based interface
4) Google maps API is used as the frontend of map at web-based interface

E) Test Drive Mockup

Testing the system developed is carried out and evaluating whether the system is as expected. If the system is not by the user requirements, it will return to the listen to customer stage to make improvements and be recorded as the prototype. The final test uses the ISO 25010 software testing quality standard and the black-box method for know system functional (Nurkholis et al., 2021).

F) Final Result

The analysis is carried out in the form of a conclusion from the system testing. The conclusion will be obtained on the geographic information system's performance and feasibility for student distribution areas mapping. The following is a range of interpretation criteria based on ISO 25010, shown in Table 1.

Table 1. Interpretation Score Range

Range (%)	Assessment
0-20	Very poor
21-40	Poor
41-60	Slightly not good
61-80	Good
81-100	Very good

3. Result and Analysis

A) GIS for Student Distribution Area Mapping

Here is an example of menus that have been developed:

1) Main menu displays the system, which contains the GIS homepage. There is a glimpse of information about the website on the main menu or homepage, and there is also a logo from the school. Here is the main page in Figure 6.

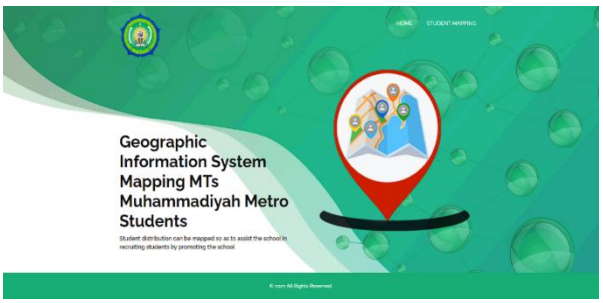

Figure 6. Main menu

2) Map menu contains a view of MTs Muhammadiyah Metro students' area distribution that the public can see. Because student information is sensitive, student personal data is hidden, where the page only displays coordinate points. The map menu can be seen in Figure 7.

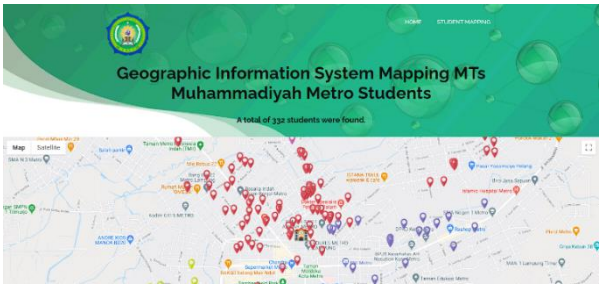

Figure 7. Map menu

3) Administrator login menu is used by administrators who can manage the GIS for Mapping MTs Muhammadiyah Metro Students. The admin himself can add

administrators. The administrator login menu can be seen in Figure 8.

Figure 8. Administrator login menu

4) Admin dashboard menu contains a list of menus that can be accessed by admins such as home, view website, student data management, geographical management, admin management, and logout. The admin dashboard menu display can be seen in Figure 9.

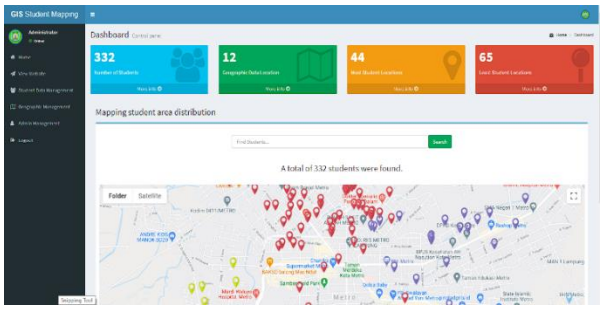

Figure 9. Admin dashboard menu

5) The admin uses the student data management menu to add, edit, or delete student data. In this menu, the admin can manage student data, search and filter. The following is the student data management menu in Figure 10.

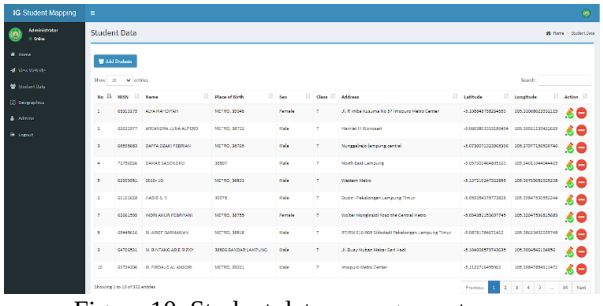

Figure 10. Student data management menu

6) Add student data menu contains a form for adding student data. In this menu, the admin can add student data, including nisn (national school registration number), class, address, longitude, and latitude. The following is the menu for adding student data in Figure 11.

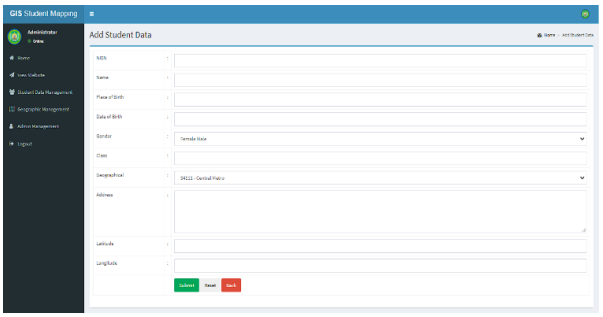

Figure 11. Add student data menu

7) The Admin can access geographic data management menu to add, delete and edit cluster marker of geographic data for student mapping. The following is the geographical data management menu in Figure 12.

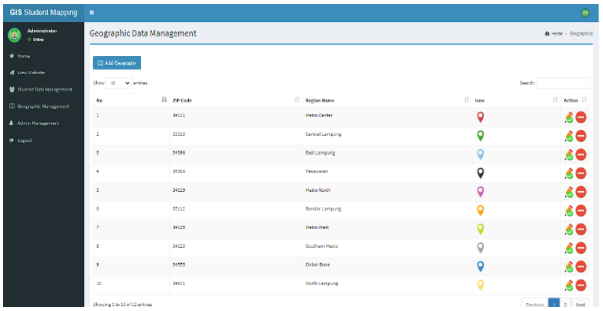

Figure 12. Geographic data management menu

8) Admin data management menu is a menu that the admin can access to add, delete and edit admin data in managing the GIS Mapping of MTs Muhammadiyah Metro Students. The following is the admin data management menu in Figure 13.

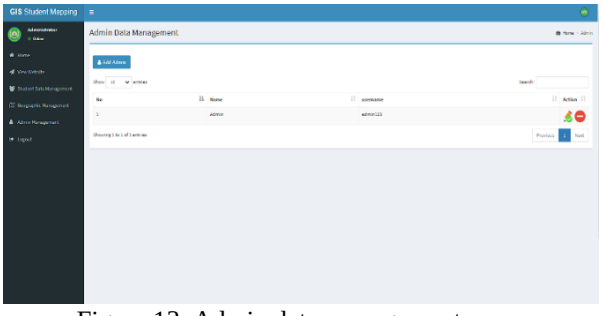

Figure 13. Admin data management menu

B) ISO 25010 Testing

ISO 25010 testing was carried out on 10 respondents from MTs Muhammadiyah Metro. Questions use answers with a scale of strongly agree (SA) = 5, Agree (A) = 4, neutral (N) = 3,

disagree (D) = 2, strongly disagree (SD) = 1. The number of questions is 32 based on a subpart of the eight aspects of the ISO 25010 category: functional suitability, reliability, usability, performance efficiency, compatibility, security, maintainability, and portability (ISO, 2013).

$$ISO\ 25010 = \frac{actual\ score}{ideal\ score} \times 100 \qquad (1)$$

Based on Equation 1, the following is the calculation of ISO 25010 test carried out:

$$result = \frac{1388}{1600} \times 100 = 86.75\%$$

The result of the ISO 25010 test analysis from all aspects stated that the system obtained a value of 86.75%, which means that it is feasible to use based on the interpretation score range in Table 1.

C) Black-Box Testing

Furthermore, the system developed was tested by 11 users with details of 1 application developer as alpha testing and 10 others coming from school, including the headmaster, administrative staff, and teachers as beta testing. Tests carried out totaled 40 functions, of which 13 functions were alpha testing processes within system development scope, while 27 functions were processes in the school system as beta testing. There are two validations in the assessment, namely the test results if accepted, the score is 1, while the rejected, the score is 0. Based on the test results, as many as 40 functions were tested to run well in carrying out their process. The following is the calculation formulation of the black-box method (Munthe et al., 2020):

$$black\ box = \frac{alpha\ testing + beta\ testing}{test\ total} \times 100 \qquad (2)$$

Based on Equation 2, the following is the calculation of black-box test carried out:

$$result = \frac{13 + 27}{40} \times 100 = 100\%$$

It can be seen that the total of 40 tests (13 alpha test functions, 27 beta test functions) can be passed with 100% results, without any errors. Based on the result obtained, the system is feasible to use, as evidenced by the application functions' work without experiencing an error.

4. Conclusion

This study successfully developed a geographic information system for student distribution area mapping by applying the prototype method. The system developed can show the distribution of students marked with a marker, making it easier to determine the location for promoting the MTs Muhammadiyah Metro school. Testing the system's feasibility using ISO 25010 produces a value of 86.75%, while functional testing using the black-box method produces 100% accuracy, which means that the system is feasible to use. The next development suggestion is that the system can be integrated with the Android operating system so that it will provide an alternative use of smartphone devices.

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