

Designing a Geographic Information System for Village Population Data Collection Using the Waterfall Method

Novita Serimuliana Br Sinuraya^{1*}, Chandra², Feriani Astuti Tarigan³

^{1,2,3}Information Systems Study Program, Stmik Time Medan

novitaserimulianas@gmail.com^{1*}, chandra.wiejaya@yahoo.com², ferianiaститime@gmail.com³

Abstract

The application of information technology in village administration management has become essential to improve the efficiency and accuracy of services, particularly in population data management. This study aims to design and implement a Geographic Information System (GIS) for population data collection in Singgamanik Village, Munte District, Karo Regency, North Sumatra Province. The development method used is the Waterfall model, which includes stages such as requirement analysis, system design, implementation, testing, and maintenance. The developed system is web-based and equipped with interactive map visualizations using the Google Maps API. It features population data management, family card data, birth, death, arrival, and relocation data. The system also includes real-time notifications for important data changes. Testing results show that the system operates effectively and enables village administrators to manage population data efficiently. System advantages include interactive map displays, ease of data management, and improved administrative efficiency. However, limitations remain, such as the absence of automatic report export features and integration with the village letter issuance system.

This system is expected to enhance the speed and accuracy of population data collection and support more targeted village development planning.

Keywords: *Geographic Information System, Population Data Management, Waterfall, Singgamanik Village, Google Maps API*

1. Introduction

The application of information technology has had a significant impact on the public service sector. The many benefits offered by information technology have encouraged governments to increase its use in various activities, especially in population data management [1]. One of the technologies that plays an important role in this area is Geographic Information System (GIS). GIS allows for the processing and analysis of location-based data, providing deeper and more useful information. It enables spatial data to be presented visually and interactively, which helps users better understand population distribution and socio-economic conditions [2]. In the field of population administration, GIS plays an essential role in compiling basic demographic data, providing population and socio-economic information, analyzing population spread, and more [2]. According to Rahayu, Muludi, and Hijriani, technological developments have advanced the way population density data is presented. Today, population data is increasingly being visualized using GIS applications, which help present information through interactive maps, making it easier to interpret and manage [3]. At the village level, accurate and efficient population data collection is essential for administration and service delivery [4]. A well-organized data system facilitates the processing and reporting of population information, which supports decision-making. Villages, being the frontline of administrative regions, are crucial in building accurate data foundations. The availability of reliable data that reflects actual field conditions is necessary to provide basic services that meet community needs [5]. In Singgamanik Village, located in Munte Subdistrict, Karo Regency, North Sumatra Province, population data collection is still conducted manually and lacks proper organization. This has resulted in various problems, such as inaccurate data, duplication, and difficulty accessing up-to-date information. To solve these issues, applying GIS in village-level population data management is a suitable solution. By integrating demographic data with geographic information and mapping households, GIS allows for more efficient data visualization and analysis. This study adopts the Waterfall method as its system development approach, which involves sequential and structured phases. Each phase must be completed before moving on to the next, making it suitable for clearly defined and well-documented system development processes. This approach is expected to produce an effective and efficient GIS-based population data system for the village. Based on this background, the research is titled: “**Designing a Geographic Information System for Village Population Data Collection Using the Waterfall Method.**”

2. Research methods

2.1. Analysis

This study was conducted to analyze the population data collection system in Singgamanik Village which is still running manually and has many weaknesses, such as data irregularities, duplication, and the absence of visualization of population distribution.

2.2. Running System Analysis

Singgamanik Village still relies on manual recording through physical documents. This makes it difficult to find data, prolongs the administrative process, and increases the risk of data corruption.

2.3. Problem Analysis

The problems found are, Data is unstructured and difficult to access, There is duplication and data is often not updated, There is no interactive map available to analyze the distribution of the population.

2.4. Proposed Method Analysis

The proposed solution is to build a Geographic Information System (GIS) using the Waterfall method, which includes the following stages:

1. Customer Communication: Interviews with village officials and communities regarding system needs.
2. Planning: Time planning and system features
3. Modelling: Designing GIS-based system features according to the results of the analysis.
4. Contruction: The development of systems using web technology.
5. Deployment: Test the system to village devices through questionnaires.

2.5 Proposal System Analysis

The system is designed using Use Case Diagrams and interaction scenarios that describe features: manage population data, family history, birth, death, move, immigrant, and hamlet location. Administrators as the main actors can add, edit, and view resident locations interactively.

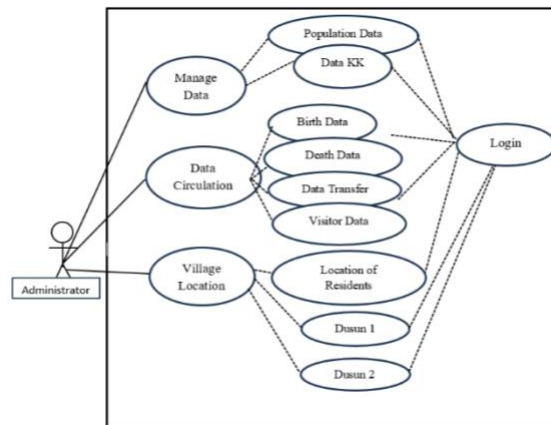


Fig. 1: GIS Village Population Data Collection

2.6 Database Design

The following is the structure of the table using the Entity Relationship Diagram (ERD).

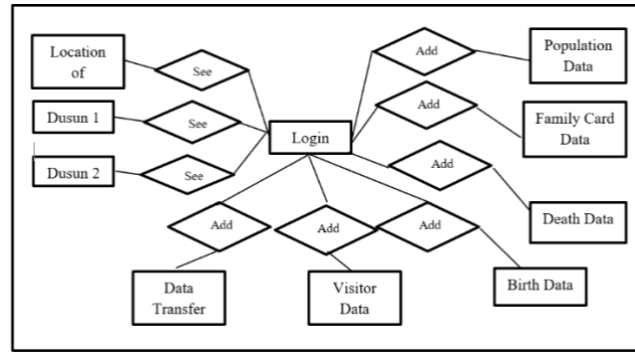


Fig. 2: ERD Geographic Information System for Collecting Village Population Data

3. Result and discussion

3.1. Website display result

The display and website of the Geographic Information System for Village Population Data Collection using the Waterfall Method for Village Population Data Collection only displays the admin section.

- a. When running the *admin section* of the Village Population Data Collection Information System website using the Waterfall Method. For Village Population Data Collection, a login display will appear.

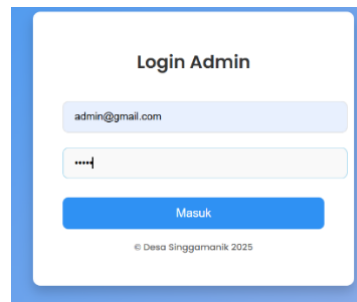


Fig. 3: Results of the login page display

- b. Dashboard page display

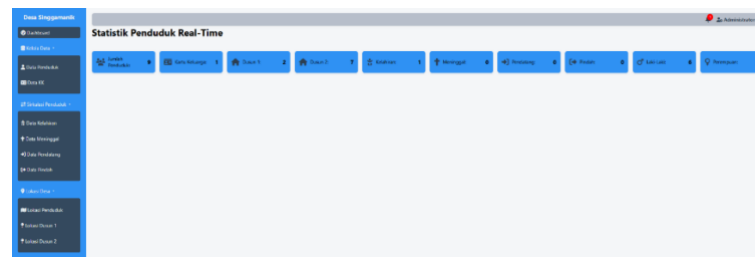


Fig. 4: Results of the dashboard page display

- c. Family Card Data Page display

No	No. KK	Kepala Keluarga	Kartu Keluarga	Dusun	Aksi
1	1206063101803300	ERWIDY S. PELAMU	KK	Dusun 2	🔍 🗑️ 📄
2	1206060208160001	MARIA MIKA MELUALA	KK	Dusun 2	🔍 🗑️ 📄
3	12060602307140002	SANDY GINTING	KK	Dusun 2	🔍 🗑️ 📄
4	1406151105120008	ITON SEMBRING	KK	Dusun 1	🔍 🗑️ 📄
5	1206062507130009	ROY APRILIANTA DEJARI	KK	Dusun 1	🔍 🗑️ 📄
6	137108132020041	BUKTI GINTING	KK	Dusun 1	🔍 🗑️ 📄
7	1206061108160010	AULIYAHATI BR SINURAGA	KK	Dusun 2	🔍 🗑️ 📄
8	1271031106190001	RUKUN EFFENDI SINURAGA	KK	Dusun 2	🔍 🗑️ 📄

Fig. 5: Results of the family card data page display

d. Display of Data Input Page

Fig. 6: Results of the Input data Page Display

e. Birth Data Page Display Results



No	Nama	Tanggal Lahir	Jenis Kelamin	Keluarga	Aksi
1	GRCELLA ELM BIR MELUALA	2025-06-26	Perempuan	1206060208160001	 

Fig. 7: Results of the Birth Data Page Display

f. Resident Location Results Page Display



Fig. 8: Results of the Resident Location Page Display.

4. Conclusion

Based on the discussion that has been presented in the previous chapters, the author can generally conclude some of the following:

1. The system was successfully built using the Waterfall method gradually and systematically, starting from needs analysis to system testing.
2. The implementation of the system is able to increase efficiency and accuracy in the management of population data, replacing manual processes with digital ones.
3. The interactive map feature makes it easier for village devices to see the location of the population geographically and support regional planning.

5. Suggestions

To ensure the proposed system functions optimally, it is recommended to add an automatic report generation feature in PDF or Excel format to support faster and more systematic village administration. Image management should also be improved by including preview and automatic compression features to enhance storage efficiency. Additionally, the system should be integrated with a letter generation module, such as for domicile, relocation, or death certificates, to streamline and simplify administrative services for the community.

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