

GeoJSON Implementation for Demographic and Geographic Data Integration Using RESTful Web Services

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Abstract—There are 69 urban villages in Tasikmalaya, and each one has its own information system including demographic and geographic information. The fundamental issue with this study is that the demographic and geography data for each urban village have not been integrated. The answer is to use Restful API to build a comprehensive urban village information system. The technology is used to integrate spatial and population data by connecting them. The performance of access to demographic and geographic data information in each urban village in Tasikmalaya City can be improved by an integrated system. For population data, JSON is utilized, and for geographic data, GeoJSON. Each REST API is put through tests using Jmeter to gauge how well it performs in terms of response time and the volume of data the urban village information system receives. The study's findings, specifically how well each urban village information system integrated geography and population data. According to Jmeter test findings, it typically takes 14.7 seconds for the REST API SIKEL to load population data. The loading of geographic data in GeoJSON format via the typical GIS REST API takes 38.4 seconds.

Keywords—GeoJSON, Information Systems, Integration, Restful API

I. INTRODUCTION

The development of information technology has a large enough influence along with the globalization era of digital technology to accelerate the flow of information. This development changes the characteristic relationship between humans, businesses, and the relationship between government and society [1]. Information has become a necessity in people's lives, so the use of information technology developments today requires everyone to be able to keep up with technological developments. Furthermore, information systems support decisions based on the information made and can guarantee the quality of the information displayed.

As technology develops, faster and more accurate information is needed, and the existence of an information system has also become an absolute necessity for companies to carry out business processes. Accessibility of information has a strong influence on the way of thinking and remembering [2]. Information technology helps humans to obtain information from various sources quickly to save energy, time, and resources. An integrated system is a set of processes that physically and functionally link multiple computerized systems and software. According to [3] in his journal entitled "Web-based Village Musrenbang Data

Integration System," an integrated system can speed up the reporting process to minimize costs, time and effort.

Based on previous research, data integration between information systems was successfully implemented using RESTful Application Programming Interface (API) [4], [5], then integrated data from academic information systems, namely student data. Data integration using Restful API web service on the website, database using MySQL and PHP programming language. The data in the web service response uses JSON format. To access the web service, what is done is to send username and password data in JSON format [6], [7].

The REST API is also not only for data with a JSON format; data that uses the GeoJSON format can also use REST API to exchange geographic data. For example, in the research conducted by Da Costa, the REST API can be used to provide spatial data using the GeoJSON data format in Geographic Information Systems [8].

The city of Tasikmalaya has 69 urban villages and ten sub-districts. Each urban village has its information system called SIKEL or an urban village information system [9]. Population and geographic data are indispensable for the urban village information system to provide information to the public on matters relating to the population and the geographical boundaries of each urban village in the City of Tasikmalaya. However, SIKEL's current condition still needs an integrated information system in its data distribution, so the solution proposed in this research is to create an integrated information system to bridge the data integration in SIKEL. In this study, integration was carried out using the restful API method to bridge demographic and geographic data for use by SIKEL.

II. MATERIAL

A. Information Systems

An information system is a set of components consisting of systems that are interconnected to produce domain-specific information. The information system is organized to process data into information for problem-solving and decision-making [10]. An information system is a collection of interrelated components produced. Information meets organizational goals. Each component has the functions of gathering, processing, storing, analyzing, and applying information. An information system is an organization used as a data processor to produce reports presented to certain parties. Information systems are designed to convert data into useful information [11].

B. REST API

REST (Representational State Transfer) is an architectural method of communication used to develop web services. REST architecture is usually implemented via HTTP (Hypertext Transfer Protocol), which reads web pages containing JSON or XML format files. The file defines the contents of the content to be served. After the definition process on the file, consumers can access the standard application program interface [12].

C. JSON

JSON (JavaScript Object Notation) is a data format for data exchange and storage. JSON is usually used as the standard format for data exchange between applications. In addition, the application of JSON is often used as a format for exchanging data between servers and clients or between applications, for example, in the RESTful API data exchange format [13].

D. GeoJSON

GeoJSON is an encoding format that uses various geographic data structures based on the JSON (Javascript Object Notation) format. GeoJSON supports various types of geometry, such as Point, LineString, Polygon, and many other types. Point is usually used to describe address and location. The LineString type is usually used to describe highways and boundaries. Polygons are usually used to describe areas such as countries, provinces, and parcels of land [14].

E. RUP

RUP (Rational Unified Process) is a software engineering approach with the main characteristics, namely the use of a use-case-driven and iterative approach for software development. The systems development process covers all phases of software development, using methodologies to assist tasks and responsibilities in organizational development. RUP is an iterative software development model, assigning responsibilities and tasks within an organization to ensure the production of high-quality software. This means that user requirements can be predicted with the fulfillment of schedules and budgets. Figure 1 is a model of the RUP method [15].

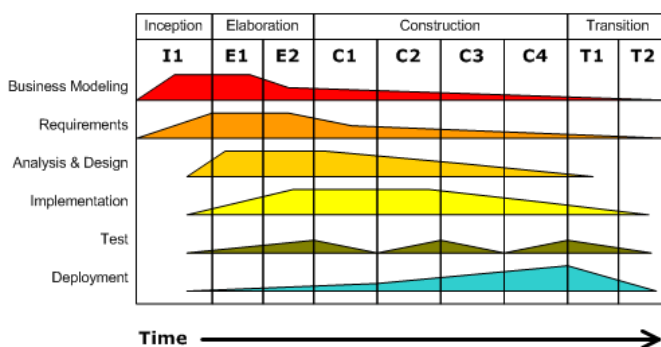


Fig. 1. Rational Unified Process

F. Apache Jmeter

Apache JMeter is a 100% open-source pure Java application designed to measure performance and test functional behavior. Apache Jmeter is designed to test web-based applications and tests the performance of static web resources and dynamic web applications. Apache simulates the load borne by a network, server, server group, or object. Analyze its performance or test its strength thoroughly under

various types of loads. JMeter is not a browser; it works at a certain protocol level when it comes to remote and web services. Therefore, JMeter does not perform all the operations used by the browser. For example, JMeter cannot precisely execute any Javascript in HTML [16].

G. Postman

Postman is an application used to test the functionality of the REST API by acting as a Rest Client. Developers generally use Postman as a tool that will test APIs and create APIs. Postman has features that can be used for free or paid, and individuals or groups can access that. In addition, the Postman is used to putting together APIs that can be fully documented in a given project. API documentation can be done using Postman, which will simplify the project development process because each developer can have an apparent reference for using each API [17].

H. Related Works

In Research [18], selecting frameworks and methods for accessing databases is essential in developing information systems. CodeIgniter is a PHP framework that can offer speed and integration between 2 servers using Restful API. In addition to the system performance information, JQuery provides improved process performance and an attractive interface. Therefore, a better information system development model results from selecting the proper framework. The result combines the Codeigniter framework and RESTful API, and the final project management system can be well integrated.

In research [19], the geographic information system created combines the PostgreSQL, PostGIS, and MySQL databases. The map is created using Leaflet with Geojson data format, loaded through a web application. Using satellite imagery can improve the quality of the landslide risk hazard map.

In research [8], web GIS storing and querying unstructured spatial data uses a NoSQL database, namely MongoDB, and provides spatial data in GeoJSON via REST API. The results show that MongoDB has substantial advantages over relational databases in storing and querying large amounts of unstructured spatial data due to its support for storing data with different structures and the efficiency of its spatial operators.

In previous research, no one has used the REST API for inter-system integration using data in JSON and GeoJSON formats. Instead, the integration system uses the Codeigniter 4 framework and Restful API to connect data from the server to the client. The integrated data includes population data in JSON and geographic data in GeoJSON.

III. METHODOLOGY

This stage plans every step taken in the research. Figure 2 is an explanation of the stages carried out in the research, from the start of the research to completion.

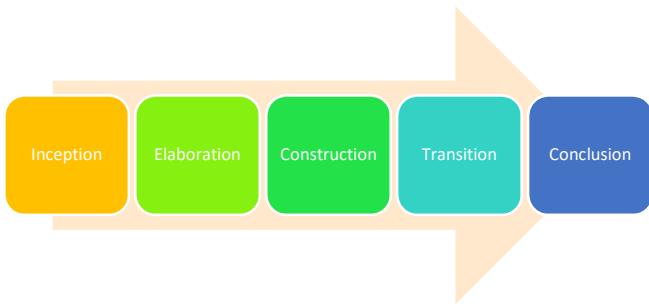


Fig. 2. Methodology

A. Inception

1) Literature Study

The literature study stage is carried out to produce several theories used as references in research, which are contained in the theoretical foundation chapter. References in the literature study are obtained by reading related research journals and reading the results of the thesis of the older brother in the library.

2) Problem Identification

Currently, the City of Tasikmalaya Urban village Information System or SIKEL is still not integrated into the population and geographic data, so information services for each urban village are ineffective. The solution proposed to deal with problems in the information system is to build an integrated information system to connect 69 urban village information systems. Integration is carried out on demographic and geographic data using the Restful API.

3) Data Collection

The collection was obtained from population data that the Tasikmalaya City Diskominfo had provided as a data provider in the study. The population data is then divided into each urban village and sub-district. The population data is then stored in CSV (Come Separated Values) format before being added to the database, which will then be converted into JSON form, and prepared for the REST API as a web service that bridges the distribution of data between urban village information systems. Finally, the data is tested to measure performance or see the performance of the web services provided.

B. Elaboration

This stage describes the design of the research. First, the design of the integrated system architecture can be seen in Figure 3, and then Figure 4 illustrates the data integration of the methods used in the system architecture.

1) Integrated System Architecture

In Figure 3, the integrated system design architecture describes the components that must exist in the system. The following are some systems that must be provided:

- SIKEL is a rest server for population data.
- GIS as a rest server from geographic data.
- Client SIKELs, totaling 69 information systems according to the number of urban villages in Tasikmalaya City. Functions as a rest client that requests the REST API and receives data as a response. Then the demographic and geographic data can be used by each client SIKEL.

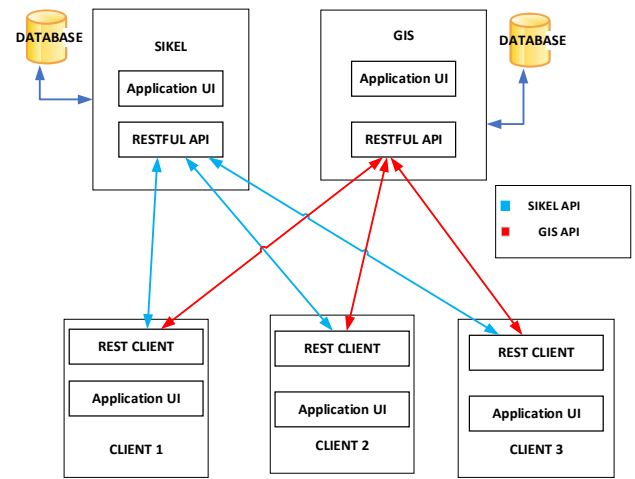


Fig. 3. Urban village Information System Integration Architecture

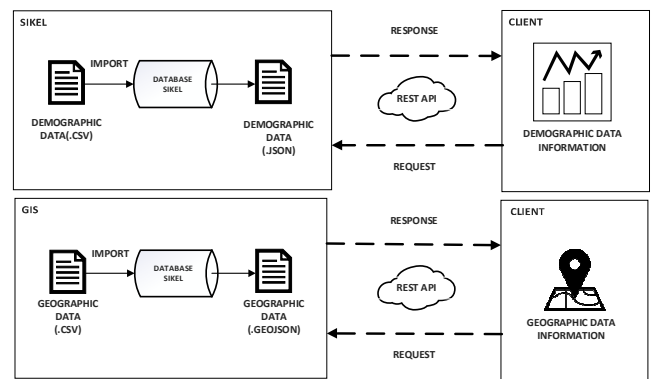


Fig. 4. Illustration of population and geographic data integration

2) Hardware dan Software Requirements

Hardware and Software are device used in an integrated system design, the component specifications of the equipment used can be seen in table 1 and table 2.

TABLE I. SOFTWARE

Software	Specification
Operating Systems	Windows 11 Home 64 bit
Web Server	Apache
Database	MariaDB
Web Browser	Microsoft Edge
Text Editor	Visual Studio Code, Sublime, Ms. Excel
Testing Tools	Postman, Jmeter

TABLE II. HARDWARE

Hardware	Specification
Processor	intel I5-1035g1 3.60 GHz
RAM	16GB 2666 MHz
Storage	SSD Nvme 256GB

C. Construction

The process carried out at this stage is the coding process using the designs prepared in the previous stage. This process is carried out with a predetermined programming language and system modeling. The technology used to manufacture an integrated information system is shown in table 3.

TABLE III. TOOLS

Programming Lang	PHP, HTML 5, CSS, Java Script
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Framework	Codeigniter 4
Webservice	REST API
Map	Leaflet
Format data	JSON, GeoJSON

D. Transition

Activities carried out at this stage, namely testing on restful API using Postman and Jmeter applications. The Postman application is in charge of testing requests and responses from the API provided by the rest server, while the Jmeter application tests the restful API's performance.

E. Conclusion

This is the final part where in this stage, the research will conclude from the results of the tests in the research that has been done, whether the results are by the plan. If they are not appropriate or produce other problems outside the study's limitations, it will be a suggestion for further research.

IV. RESULT AND DISCUSSION

The results of the tests carried out are divided into two according to the application used, Postman to test the REST API and Jmeter, to test the performance of the REST API. Furthermore, the tested REST APIs are divided into two types: SIKEL REST API for population data and GIS REST API for geographic data.

A. Postman Test Results

Tests were carried out by the Postman application, namely testing the REST API of each data. API SIKEL for testing population data and API GIS for geographic data.

1) SIKEL API

The stages carried out in the test start from testing the API address. For example, figure 5 is part of testing the circular API address by making a request using the GET method. Figure 6 is the result of the request made.

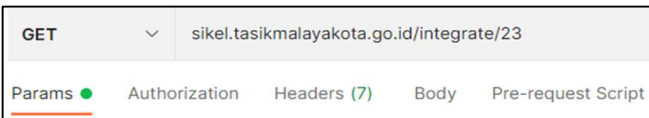


Fig. 5. Request API SIKEL urban village id 23.



Fig. 6. API SIKEL Results

In addition to testing with the id 23 parameter, which shows the results of the Cipedes urban village population data, testing is also carried out on the id above 69 in Figure 7, and a request is made using the id 70 parameters. Figure 8 is the result of the response to the request.

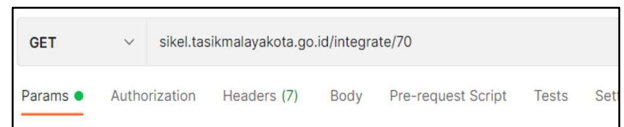


Fig. 7. Request API SIKEL id 70



Fig. 8. No results found

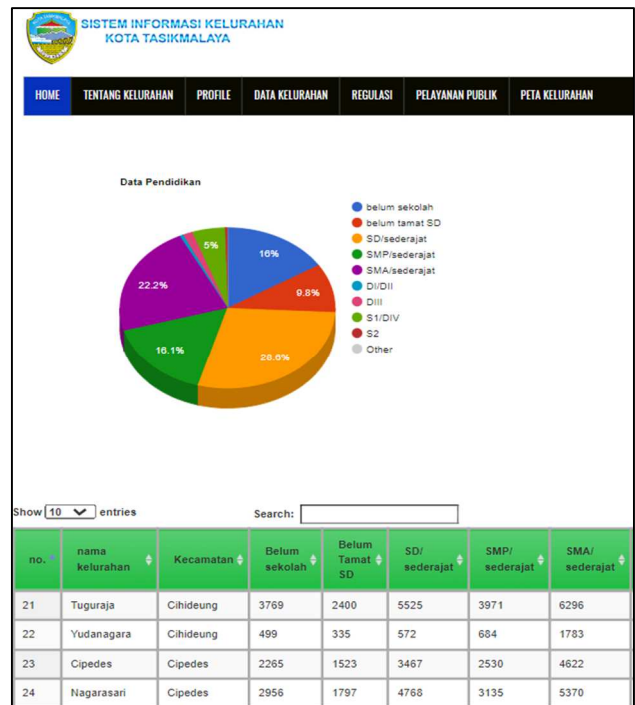


Fig. 9. Population Data in education.

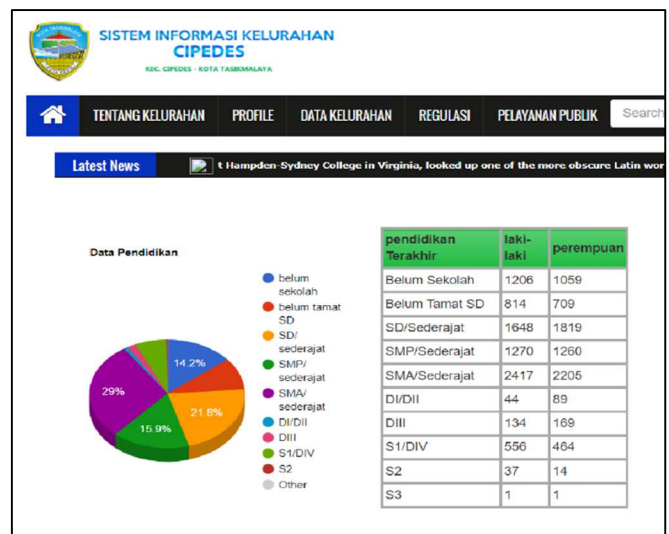


Fig. 10. Implementation population data from API SIKEL.

The tests on the SIKEL API aim to see the results of the response from the SIKEL REST API. The tests include requesting the GET method to get population data based on population ID. If the data is found, the response status, which is "200 OK" will display the requested population data. On the other hand, if the data is not found, the response status, namely "404 Not Found" will display an error message. In addition to displaying in JSON form, this test also displays the results of the implementation of population data processing into graphical information, as in Figure 9, and Figure 10 displays population data obtained from the SIKEL REST API.

2) API GIS

The stages carried out in the test start from testing the API address. For example, fig. 11 is part of testing the GIS API address by making a request using the GET method. Fig. 12 is the result of a request made using the parameter id 69.

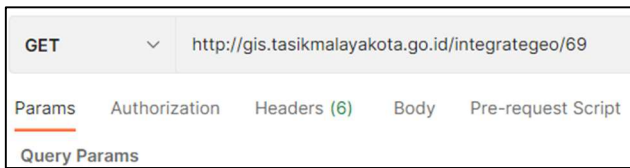


Fig. 11. Request API GIS id 69

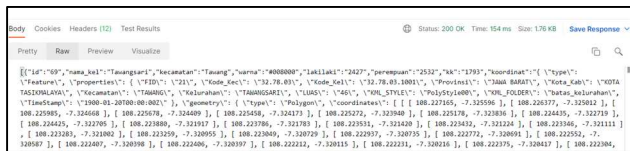


Fig. 12. API GIS Results

In addition to testing with the parameter id 69, which shows the results of the population data of the urban village of Tawangarsari, a request is also made using the parameter id 70. Fig. 14 is the result of the response to the request.



Fig. 13. GIS API not found.



Fig. 14. Implementation API GIS

The tests carried out on the GIS API aim to see the results of the response from the GIS REST API. The tests include requesting the GET method to get population data based on population ID. If the data is found, the response status, which is "200 OK" will display the requested area boundary data in the form of GeoJSON. On the other hand, if the data is not found, the response status, namely "404 Not Found" will display an error message. In addition to displaying in the form of GeoJSON, this test also displays the results of the implementation of geographic data processing, which is converted into regional boundary information in maps in each urban village information system, as shown in Fig. 14 and Fig. 15 displays a map of the boundaries of the entire urban village, Fig. 16 displays a map of integration demographic dan geographic data.

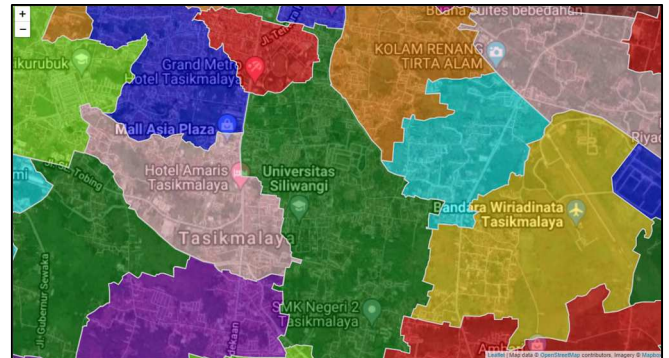


Fig. 15. Boundary map

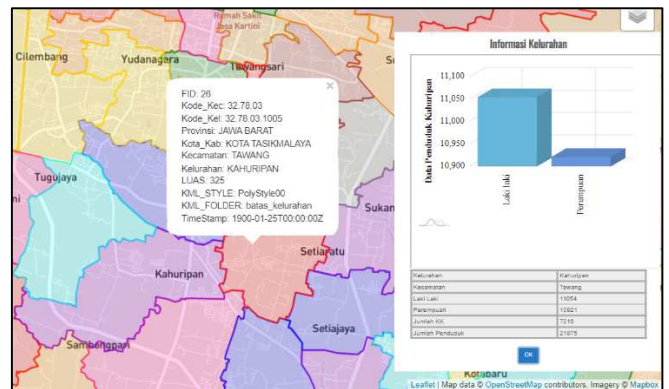


Fig. 16. Implementation of integration

B. Jmeter Results

The tests conducted by Jmeter measure the speed of loading data and the size of the data received. The unit of measure used in measuring the speed of loading data is milliseconds, while the size of the received data is kilobytes. The number of users in the test is 69, as many as the number of urban villages in Tasikmalaya City. Measurements are divided into three classes: measurement of size, response time, and error rate.

1) Size test results

TABLE IV. SIZE TEST RESULTS

Total Request	SIKEL	GIS	Difference
100	357,162 kb	1225,785 kb	868,623 kb
200	344,759 kb	1097,222 kb	752,463 kb
300	338,26 kb	965,589 kb	627,329 kb
400	300,46 kb	822,076 kb	521,616 kb
500	308,253 kb	555,252 kb	246,999 kb

Average	329,779 kb	933,1848 kb	603,406 kb
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Tests are carried out, namely testing the size of the data received by the information system. The data received are data from the SIKEL API and GIS. Table 4 is the result of testing the data size using the API from testing the data when all urban village APIs are accessed.

2) Test results in speed response time

The next test is to test the response speed of the SIKEL API and GIS. Table 5 is the result of testing the response time required to load the API, while Table 6 is the result of errors in each process to respond to requests.

TABLE V. RESPONSE TIME RESULT

Total Request	SIKEL	GIS	Difference
100	5791 ms	20900 ms	15109 ms
200	10351 ms	27551 ms	17200 ms
300	15374 ms	32341 ms	16967 ms
400	18579 ms	51220 ms	32641 ms
500	23742 ms	60242 ms	36500 ms
Average	14767,4 ms	38450,8 ms	23683,4 ms

TABLE VI. ERROR RATE RESULT

Total Request	SIKEL	GIS	Difference
100	0%	1%	1%
200	3,5%	30%	26,5%
300	6%	38,67%	32,67%
400	16%	46%	30%
500	20%	57%	37%
Average	9%	35%	25%

V. CONCLUSION

The results of the tests carried out by the Postman application on the SIKEL REST API and GIS REST API can be declared victorious. Proof that the data from the REST API was successfully retrieved by showing a response status of "200 OK". In addition, the data obtained is also used according to system requirements. For example, population data is used for population information purposes in a graphical display. In contrast, geographic data is used as area boundary information in maps in the urban village information system.

Jmeter test results show that after going through 100-500 requests for SIKEL, the REST API requires an average of 14.7 seconds to load population data. Meanwhile, the average GIS REST API requires 38.4 seconds to load geographic data in GeoJSON form. The test results in this study, namely the integration of population and geographic data in the urban village information system of Tasikmalaya City using the Restful API, were successfully carried out and the performance of the REST API tested was fast enough to access population data and geographic data.

This research has several shortcomings, including the REST API still need to use an API key for security, and the system created needs to implement load balancing to optimize the client connection to the server.

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