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Implementation of Web GIS for Telecommunication Tower Control Using Genetic Algorithm

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Abstract:

In the current digital era, with the development of supporting technology for Geographic Information Systems (GIS) and spatial database applications, advances in internet technology, and information technology, the ease of GIS can increasingly be enjoyed by the wider community through the internet using a web browser. One of the contributions that have been shown to the development of digital technology, one of which is Google, a United States multinational company engaged in Internet services or products. Various products offered by Google are increasingly in demand by the public, including Web Browsers and Google Maps, currently, web browsers and Google Maps are very helpful for the general public and application development companies for information sources. The Department of Communication and Information (DISKOMINFO) of Karawang Regency is currently tasked with managing the layout of the construction of telecommunication towers spread throughout the Karawang regency. The problems faced by Diskominfo at this time are; In mapping, the deployment area of the Base Transceiver Station (BTS) tower has not been accommodated properly due to problems with the storage and mapping system that is still being made in the semi-computerized form, resulting in the location of the distribution points and the determination of the location for the new tower is difficult to detect, the requesting party especially individuals and companies when they want to apply to build telecommunication towers, they still don't know much about the information and requirements that must be prepared. The approach method used in this research is a structured design approach. Through a structured approach, complex problems in the organization can be solved and the results of the system will be easy to maintain, flexible, more satisfying to users, have good documentation, on time, by the development cost budget, can increase productivity and quality will be better. With this system, users, both the Department of Communication and Informatics, Karawang Regency, or the Community, are expected to be more assisted, so that every control activity of telecommunication towers becomes monitored, effective and efficient..

Keywords — Diskominfo, GIS, Genetics, RAD, WEB.

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I. INTRODUCTION

In the current digital era, with the development of supporting technology for Geographic Information Systems (GIS) and spatial database applications, advances in internet technology and information technology, the ease of GIS can increasingly be enjoyed by the wider community through the internet network using a web browser (Muttakin). , 2017). One

of the contributions that have been shown to the development of digital technology, one of which is Google, a United States multinational company engaged in Internet services or products. Various products offered by Google are increasingly in demand by the public, including Web Browsers and Google Maps, currently, web browsers and Google Maps are very helpful for the general public and also application development companies for sources of information, for example, those developing in Indonesia such as Gojek, Grab, Traveloka, Marketplace, and many others.

Telecommunication is any transmitting, sending, and or receiving of any information in the form of signs, signals, writings, images, and sounds through wire systems, optics, radio, or other electronic-systems. Towers or in Indonesian called - telecommunications towers are buildings for public purposes that are erected on land or buildings which are communication units with buildings used for public purposes whose physical structure can be in the form of a steel frame tied by various knots or in the form of a steel frame. a single node without a node, where the design and construction functions are adjusted as a means of supporting the placement of telecommunications equipment.

Regulations for the construction of - telecommunications towers are contained in the regulation of the Minister of Communication and Information Number: 02/Per/M.Kominfo/03/2008 concerning guidelines for the construction and use of telecommunications towers (Permenkominfo 02/2008). In addition, it is also regulated in a joint regulation of the Minister of Home Affairs, the Minister of Public Works, the Minister of Communication and Information, and the Head of the Investment Coordinating Board Number 18 of 2009; Number: 07 / Prt / M / 2009; Number: 19/ Per / M.Kominfo / 03 / 2009; Number: 3 / P / 2009 concerning Guidelines for the Construction and Shared Use of Telecommunication Towers.

The construction must have a permit to build a tower from the competent authority. What is meant by a permit to build a tower according to Article 1 point 10 of Permenkominfo 02/2008 is a permit to construct a building by the prevailing laws and regulations.

The Karawang Regency Government of - Answerarat Province, especially the Office of Communication and Information (DISKOMINFO) of Karawang Regency, is currently still collecting data related to licensing for the establishment of telecommunications towers with a system that has been built offline which of course still has limitations. Based on the results of the presentation of the head of KOMINFO Bekasi and IT staff. Whereas data collection activities are currently not effective, because the location points for the deployment of telecommunication towers are not mapped so that the division of territory and determining the location for new towers are difficult to detect. should be prepared.

Based on these problems, it is necessary to create a system that can control telecommunications towers in the Bekasi district government, so that every new tower licensing activity is monitored, more effective, and efficient.

II. THEORETICAL BASIS

A. Geographic Information System (GIS)

Geographic Information System (GIS) or Geographic Information System (GIS) is part of an information system that is combined with features or data and spatial analysis that can help users understand and analyze problems more comprehensively (Ramamurthy et al, 2009).

A geographic information system consists of computer systems, geospatial data, and users. According to Prahasta (2001), geographic information systems represent the real world (real world) on a computer monitor such as a map sheet that can present the real world on paper but has more power and flexibility than a sheet of paper (Rizki et al, 2016).

B. Web-Based GIS

A web-based Geographic Information System (GIS) is an application that can be applied and run using the internet network on a web browser. The application runs on the internet in a global network, in a LAN network or local network, and on computer devices that already have a web server (Prahasta, 2007).

According to Ramadhan Susilo Utomo, Arief Laila Nugraha (2020), GIS is generally developed based on the principles of data input, management,

analysis, and data representation. In the web environment, GIS principles are described and implemented as shown in the following table 1:

Table 1. GIS principles and WEB development

Principles of GIS	WEB Development
Input Data	Client
Data Management	DBMS with special components
Data Analysis and Manipulation	GIS Library on Server
Data Representation	Client/Server

C. Services On Google Map

Google Maps is a web mapping service developed by Google. This service provides satellite imagery, street maps, 360° panoramas, traffic conditions, and route planning for traveling by foot, car, bicycle (beta version), or public transport. Google Maps started as a C++ desktop program, designed by Lars and Jens Eilstrup Rasmussen at Where 2 Technologies.

In October 2004, the company was acquired by Google, which was turned into a web application. Following additional acquisitions of a geospatial data visualization and traffic analysis company, Google Maps was launched in February 2005. The service uses Javascript, XML, and AJAX.

Google Maps offers an API that allows maps to be included on third-party websites and offers location pointers for urban businesses and other organizations in various countries around the world. Google Maps Maker allows users to jointly develop and update mapping services worldwide (Hermawan et al, 2020).

By default, the Directions service calculates routes through a given waypoint in a specific order. Optionally, you can pass optimizeWaypoints true in the Direction Request to allow the Directions service to optimize the provided route by rearranging the waypoints in a more efficient order (Annugerah et al, 2016).

D. Model Rapid Application Development (RAD)

The Rapid Application Development (RAD) method as stated by James Martin consists of four phases: requirements planning phase, user design phase, construction phase, and cutover phase. Each phase will be carried out sequentially to develop CLIS, starting from the requirements planning phase and ending with the cutover phase (Kosasi and Yuliani, 2015). The following is a cycle of RAD on Fig. 1:
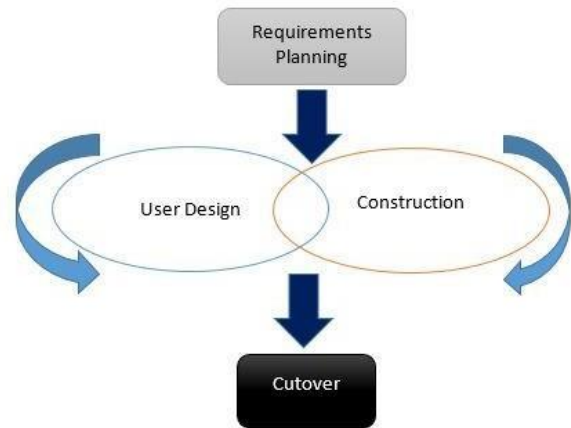

Fig 1. Rapid application development (RAD) method (Wahyuningrum and Januaryta, 2014).

The four main phases of RAD can be divided into several more specific phases as depicted in Figure above. The general purpose of phase breakdown is to provide step-by-step information for developers who will try to use the RAD model to build software. As seen in the figure, there are 2 if-conditional loops, each loop indicating how strongly the user is involved in the model. For example, the first loop shows that the requirements planning phase will not advance to the next phase when the information about the system requirements is incomplete and the completeness of the information is decided by the user. Details about each main phase of RAD and the results of each phase will be explained in the next section (Wahyuningrum and Januaryta, 2014).

E. Genetic Algorithm

Genetic Algorithm As a branch of the Evolutionary Algorithm is an adaptive method that can be applied in solving the value search problem in an estimation problem (Cynthia, et al, 2019).

In solving the genetic algorithm, the steps that must be carried out are as follows:

1. Chromosomal Formation

The formation of chromosomes is to determine the Genetic Parameters:

a. The population number (pop_size) is a number that indicates the number of chromosomes.
b. The number of generations (max_gen) is a number indicating the number of generations processed.
c. The crossover probability (Pc) indicates the probability of the chromosomes in a population crossing over.
d. Mutation probability (Pm) is used to indicate the probability that many genes will be mutated

2. Chromosome Evaluation

Chromosomal evaluation is carried out by calculating the following:

a. Objective Function Calculation Stage (FO)
   After obtaining a feasible trajectory, the next stage is the calculation of the objective function value. The objective function is the calculation of all the sides formed from the genes on a chromosome. Suppose there are as many as n genes on a chromosome, then the FO of that chromosome is:

$$FO = V_{1:2} + V_{2:3} + \cdots + V_{n-1:2} \ (1)$$

b. Fitness Value Calculation Stage
   The fitness value is the value that will be used as an optimization function of a goal, the optimization to be achieved is to get the most minimal distance. Then the smallest objective function will get the fitness value with the largest value, then the function is as follows:

$$Fitness = [i]\frac{1}{FO\,[i]} \ (2)$$

3. Chromosome Selection

The selection method used is the Roulette Wheel selection. The way these method works is as follows:

a. Calculate the probability value of each chromosome, denoted:

$$P[i] = \frac{Fitness}{Total\ Fitness} \ (3)$$

b. Calculating the cumulative probability of each chromosome, defined K[0] = 0

$$K\,[i] = K\,[i-1] + P\,[i] \ (4)$$

This process is like making a Roulette Wheel board.

c. Generating a random probability value R[i] as much as pop_size for the selection stage. Selection stage.
d. Determine the new population that is formed, provided that if

$$K\,[h] = K\,[h-1] <= K\,[h] \ (5)$$

then the i-chromosome changes to the h-chromosome.

4. Crossover (Move Cross Point)

The process of recombination crossing over or crossover is crossing two chromosomes to form a new chromosome that is expected to be better than the previous chromosome. Not all chromosomes in pop_size will undergo a recombination process. The probability that a chromosome will undergo a crossover process is based on the probability of crossing over that has been found beforehand. The crossover probability can state the number of chromosomes to be a crossover.

5. Mutation

The process of point mutation or exchange is carried out after the recombination or crossover process by selecting the chromosomes to be exchanged randomly and then determining the point exchange of the chromosomes. The number of genes that will undergo exchange is calculated based on the mutation probability that has been determined in advance. If the mutation probability is 100% then all the genes in the set will experience Edi Ismanto, Genetic Algorithm for exchange. On the other hand, if the exchange probability used is 0%, then no genes are exchanged (Ismanto et al, 2019).

III. METHOD

In this research methodology, the RAD system development model approach (Model Rapid Application Development) is used, the following is a flow graph of this research methodology on fig. 2:
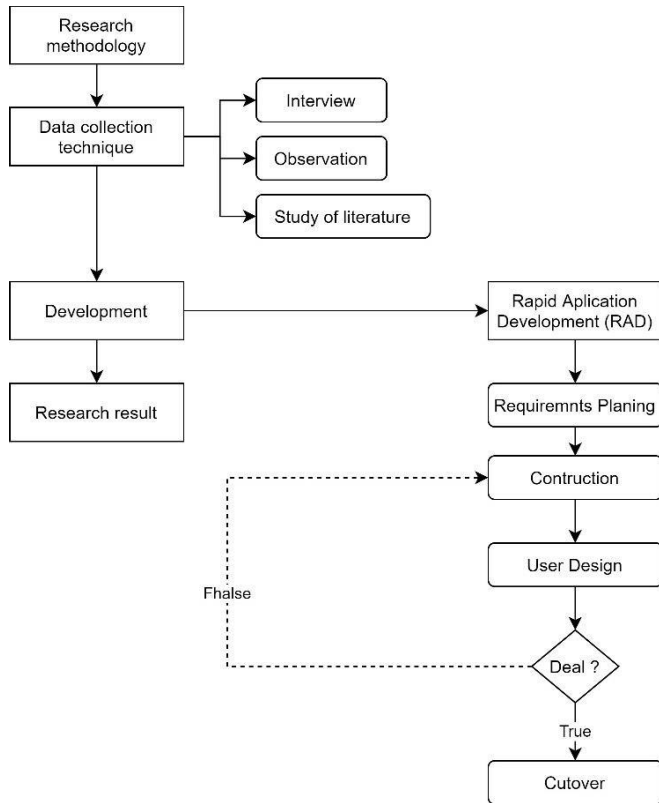

Fig. 2 Research Methodology

1. Data Collection Techniques

In collecting data the researchers used several methods, including:

a. Observation method

The observation method is the systematic observation and recording of the symptoms that appear on the object of research. This method is used to obtain information by conducting careful observations and recordings of an ongoing geographic information system (GIS).

b. Interview Method

What is meant by the interview method is a method of collecting data through observation by conducting questions and answers orally to the Karawang district government.

c. Study of literature

The literature study method is looking for data on things or variables in the form of scientific journals, books, workshop modules, notes, transcripts, books, newspapers, magazines, minutes, meetings, agendas and so on.

2. Data Analysis and Testing

Data analysis in this study used a quantitative descriptive technique that describes the monitoring system. The data obtained through the instrument were analyzed using quantitative descriptive statistics. This analysis is used to describe the characteristics of the data in each variable. This method is used to make it easier to understand the data in each process.

IV. RESULTS AND DISCUSSION

1. Construction

Construction aims to design a new system, in this study the following is a Usecase diagram of the Telecommunication Tower Control system. Use describes an interaction between one or more actors with the application to be made, use case diagrams, Activity Diagrams on the design of the Telecommunication Tower Control system:

a. Use case diagrams

Use describes an interaction between one or more actors and the application to be made, the use case diagram for designing a telecommunication tower control system is shown in Fig 3 below:
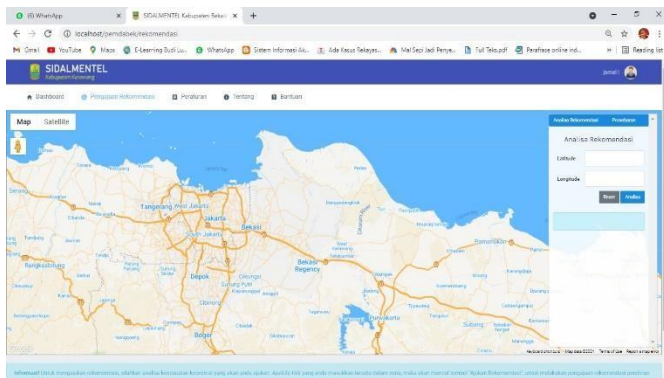
Figure 3. Usecase Diagram of Telecommunication Tower Control (BTS).

b. Class Diagram

Class diagrams serve to structure the system by defining the classes that will be created to build the system. The following is a class diagram for the telecommunication tower control system shown in Figure 4 below:

Figure 4. Class Diagram Sindalmentel

2. User Design

Interface design in the network device monitoring application system is carried out to produce a system that is by user needs. This study uses pencil tools as a tool to design interfaces or mockups.

3. Cut Over

In this chapter, the research constructs, tests, installs and provides services to users. If all the required objects have been designed, the next step is to construct the designed objects into the JavaScript, HTML, and PHP programming language code. The results of the coding system are as follows:

a. Telecommunication Tower Submission System Display

This display is used to view the status of telecommunication tower submissions on the Sindalmentel system for companies or providers that have submitted recommendations. This view can be seen in Figure 5 below:

Fig 5. Telecommunication Tower Submission System Display

b. Site Application and Validation System Display

This display is used to check the availability of telecommunication tower zones that will be submitted to the Sindalmentel system for initial reference for the registration of telecommunication towers. This view can be seen in Figure 16 below:

Fig 6. Display of Location Submission and Validation System

c. Tower Ststus Display

This display will be presented when the tele-communication tower application is received to monitor the status of the telecommunication tower. This view can be seen in Figure 7 below:
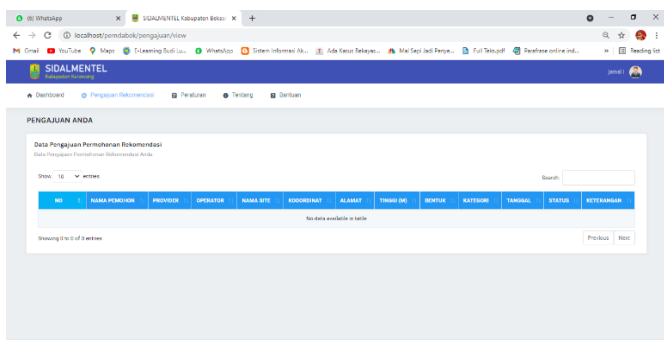

Fig 7. Tower Status Display

System Test

System testing using the alpha testing method was carried out by researchers intended to assess the performance of the GIS Web GIS software-system for BTS control both from the provider/ company side, field officers, and system admins. Assessment is carried out after each officer fills out a questionnaire form. The following is the calculation formula used:

$$\frac{k}{j} x\ 100 \quad (6)$$

Information :
k = Total of each answer from the system convenience table plus the system accuracy table
j = The total number of answers from the system

Strongly Agree   = SA
Agree   = A
Disagree   = D
Do Not Agree   = DNA
Strongly Disagree   = SD

convenience table plus the accuracy table

The results of the alpha testing can be seen in table 2 :

Table 2. GIS principles and WEB development

No	System Benefits	Results				
		SA	A	D	DNA	SD
1	Company Side	85	12	2	1	0
2	Field Officers	92	5	2	1	0
3	System Admins	91	6	3	0	0
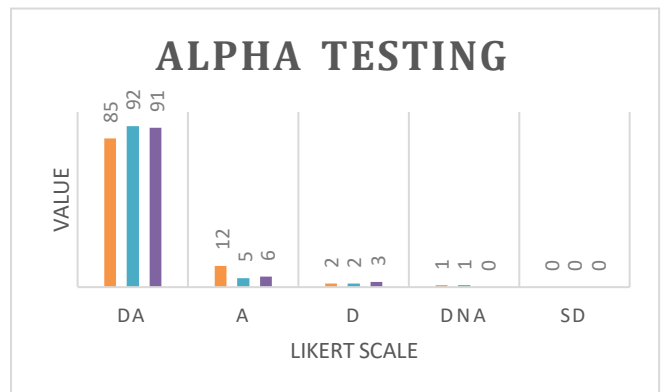
V.   CONCLUSIONS

Based on the results of the application of RAD and system analysis, the following results were obtained:

The test results based on sample company data show that 85% strongly agree, 12% agree and the rest disagree. Most companies agree with the system that has been made and only a few companies do not agree with the application. From the officers' data, it shows that 92% strongly agree, 5% agree and the rest disagree. Most officers agree with the system that has been made and only a few officers do not agree with the application. The admin data shows that 91% strongly agree, 6% agree and the rest disagree. Most of the many admins agree with the system that has been made and only a few admins do not agree with the application.

The results of the alpha testing test can be concluded that the WEB GIS system on BTS Control that has been made is easy and feasible to use. However, to get maximum results it is necessary to develop further systems, such as improving mapping accuracy and using open-source maps (Open-mapping).

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