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Analysis of the Adequacy Ratio of Health Workers Using WebGIS-Based MPE Method in Bogor Regency

Analisis Nisbah Kecukupan Pekerja Kesihatan Menggunakan Kaedah MPE Berasaskan WebGIS di Daerah Bogor

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ABSTRACT

Optimal health development requires the availability of quality health workers and spread evenly throughout the region. Puskesmas, as primary health institutions, plays an important role in prevention and promotion efforts to promote public health. However, the quality and performance of health centers are often influenced by the distribution of health workers and available facilities. This study aims to analyze the distribution pattern of Puskesmas in Bogor Regency and evaluate the potential performance of Puskesmas using the Exponential Comparison Method (MPE), the results of the MPE method show that Cibinong Regency gets the highest MPE value, which is 23417. Based on the classification results, it shows that the green colour is in the range of Rank 1-13, for the red colour in the range of Rank 14-26, and for the red dot in the range of Rank 27-40 With the application of WebGIS, a map of the distribution of Puskesmas is produced to facilitate the identification of strategic locations and accessibility of health facilities for the community. The MPE method is used to assess the performance of health centers based on certain criteria, including the availability of medical personnel and existing facilities. Based on the results of the study, it is hoped that it can be a reference for local governments in improving the quality of health services and ensuring more equitable distribution in Bogor Regency, in order to achieve better health development goals.

Keywords: Health Centers; Exponential Comparison Methods; Health Workers; WebGIS.

INTRODUCTION

The goal of better health development can be achieved if the availability of qualified health workers in an adequate number is ensured. Health workers need to be available evenly so that health centers or health providers can meet medical personnel according to their needs (Endrawati et al. 2016). Regulation of the Minister of Health No. 75 of 2014, Attachment V of Rome concerning Employment Standards for Health Centers stipulates that four types of strategic health workers (Doctors, Dentists, Nurses, and Midwives) are the minimum conditions expected so that Puskesmas activities can be carried out properly. Availability of health workers (Budijanto et al. 2015).

Health centers have an important role in the prevention and management of public health and help the performance of larger health institutions such as hospitals. In an effort to improve the quality of health services at the health center level, especially by realizing quality, efficient, and effective health services and to improve the performance of the health center itself, a good concept or system is needed (Ferris wheel and Vol. 2015). Puskesmas is a primary health institution that serves general patients and patients with health insurance. Due to its affordability, Puskesmas is the community's main choice for treatment, however, many patients complain about the quality of services provided (Kueng, 2016).

The performance of the Puskesmas according to the Ministry of Health Number 128/MENKES/SK/II/2004 concerning the basic policy of the Puskesmas, the main task of the Puskesmas is to carry out preventive and promotive efforts, supported by curative and rehabilitation efforts, as well as community empowerment. As the main provider of health services, health centers play an important role in maintaining public health. Puskesmas can provide high-quality services to people in need if they operate well (Wibowo, 2009). The description of health performance concerns 3 components, namely objective, measure, and assessment. Goals will provide direction and affect how the work behaviour is expected by the organization, steps are needed because it is not enough if only the goal setting, so that the measure of quantitative and qualitative performance standards for each task and position of a person plays an important role (Rotty, 2016) Bogor Regency has 3,819,488 people and grows at an average of 3.37% per year (Bogor Regency Population Office, 2004). It has great potential as a place for food and health consumption (Aprella, 2017). Based on 2023 research by Nanda Afrizal, Dewi Suranti, and Jhoanne Fredricka, "Decision Support System for the Best Midwife Selection by Applying the Exponential Comparison Method (MPE) Case Study of the Bandar Kota Pagar Alam Health Center". In decision-making, the exponential comparison method (MPE) includes all the alternative criteria and data, as well as the value for each alternative and the weights for each criterion. Then, this method is synchronized with the MPE stages to produce a scale of the number of ratings for each attribute to become the best performance of the health center (Kinerja, 2023).

The Exponential Comparison Method (MPE) is one way to determine the alternative priority order of decisions based on various criteria. This method helps decision-makers use a clear model design at the process stage (Rini et al. 2016).

This study aims to analyze the distribution pattern of health centers in Bogor Regency using the MPE method, in assessing the potential for the highest performance of health centers in the Bogor Regency area.

PROBLEM STATEMENT

Based on the above background, it can be formulated that the problems faced by the author are as follows:

1. How can the MPE method be carried out to determine and assess based on the number of General Practitioners, Dentists, Nurses and Midwives in Bogor Regency.
2. How to design a map of the Geographic Information System of health centers in Bogor Regency.

LITERATURE REVIEWS

Table 1: Literature reviews

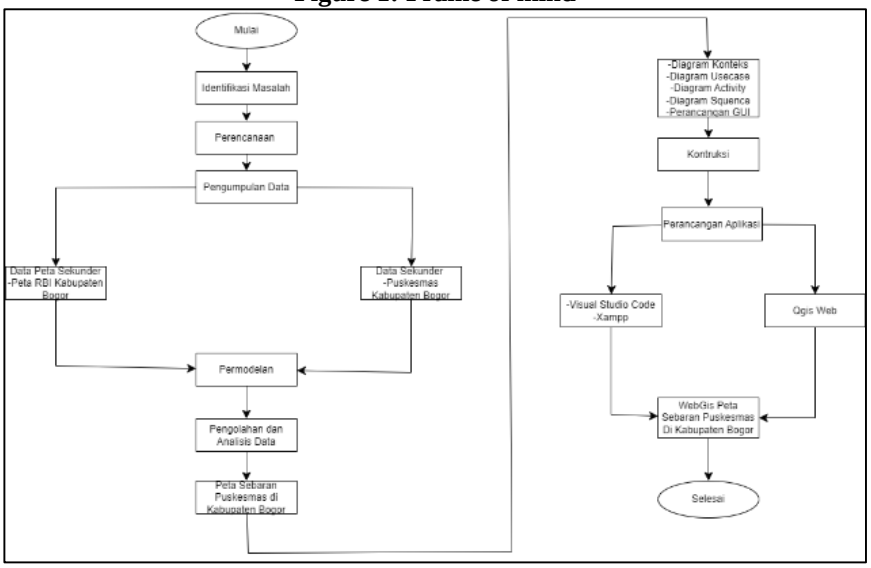
No	Author of the Year	Heading	Result	Research Gaps Addressed
1	Nanda Afrizal, Dewi Suranti, Jhoanne Fredricka (2023)	A decision support system for the selection of the best midwife by applying a case study of the Exponential Comparison Method (MPE) of the Bandar Kota Pagar Alam Health Center.	The decision support system to choose the best midwife by applying the exponential comparison method (MPE) at the Bandar Kota Pagar Alam health center will be created using the Visual Basic Net programming language and will use the SQL Server database as a storage of data processing results. There are several menus, including the application login menu, main menu, data input consisting of, midwife data, criteria data, assessment data, then the output process menu, and the exit button where on the main menu there is a system that can be connected to other menus.	It has not integrated spatial elements or geographical distribution.
2	Armiyana , Reski Mai Candra (2017)	The system to support children's school selection decisions uses the Analytical Hierarchy Process (AHP) method and the exponential comparison method (MPE).	The Exponential Comparison Method (MPE) is one of the methods to determine the order of priority of alternative decisions with various criteria. This technique is used as an assistant for individual decision-makers to use a well-defined model design at the process stage.	Not applied to healthcare or spatial distribution.
3	Yosep Agus Pranoto, Moh Miftakhur Rokhman Suryo Adi Wibowo (2018)	A Website-Based Mapping Application For Community Health Centers In The Malang Regency Area.	The problems in the scope of the lack of geographic location information that causes a lack of access to knowledge about the location of health facilities that are closest to the user's environment in Malang City can take advantage of technology from the Geographic Information System (GIS). It is hoped that from this research researchers can create a website-based geographic information system that can make it easier for the public to find the location of the desired health facility in the Malang City area using a web-based Geographic Information System (GIS).	It does not analyze the adequacy or performance of health workers.
4	Yansen Mandacan, Faizal Aco (2021)	Performance Analysis of Employees of The Depok II Health Center In Depok	This study aims to analyze the performance of Depok II Health Center Employees, Depok District, Sleman Regency, D.I. Yogyakarta. This study uses the Satuu research	Doesn't incorporate spatial or decision-making methods.

No	Author of the Year	Heading	Result	Research Gaps Addressed
		Regency Sleman Regency, Special Region of Yogyakarta.	sample technique, according to Sugiyono, which is 27 people. The analysis used is Quantitative Descriptive Analysis.	
5	Yudo Devianto, Saruni Dwiasnati (2018)	The application of community satisfaction index decision-making with Exponential Comparison Method (MPE) in Community Service Unit with a microcontroller as a survey tool.	Community Satisfaction Index Decision Making in Community Service Units Using the Method Exponential Comparison (MPE) in Community Service Units with Microcontrollers as Auxiliary Tools The survey can be summed up as follows: 1. Based on the research that has been conducted, it can be concluded that this research is ongoing well, in applying microcontrollers as survey tools. 2. The results of this study are the Community Satisfaction Index Decision Making Application which can apply it directly as a solution to solve problems that occur in community service units	It is not directly relevant to the analysis of the equitable distribution of health workers.

METHODOLOGY

The research method is carried out in the thesis preparation process including three main parts, namely communication, planning, modelling and construction. The frame of thought in this study is shown as Figure 1, a flowchart is shown in this study.

Figure 1: Frame of mind



Analysis Method

At this planning stage, data collection is carried out, namely the collection of information needed for research, analysis, or decision-making purposes. Data collection is a systematic step that must be

followed to ensure that the data obtained meets the purpose of the research or analysis being conducted. In this study, there is secondary data.

Modeling

At this modelling stage, the researcher conducts data processing and analysis. The data used are: Secondary data on the performance of the Bogor Regency health center (2021). At the stage of processing Health Worker Data, the data will be analyzed using the MPE Method, in order to assess the performance of health centers in Bogor Regency. The number of sub-districts (n = 40) covers the full population of health centers in Bogor Regency so that sampling is not required. Validation was carried out by triangulating data from the Health Office and BPS.

MPE Method Calculation (Exponential Comparison Method)

The Exponential Comparison Method (MPE) has advantages in terms of simplicity of calculation and ease of implementation, especially in multi-criteria decision-making with limited quantitative data. In contrast to methods such as the Analytical Hierarchy Process (AHP) which requires pairwise comparisons and rational consistency, or the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Simple Additive Weighting (SAW) methods which require normalization and calculation of the distance from the ideal solution, MPE simply uses weights and exponential transformations of the criterion values. Another advantage of MPE is its ability to be easily integrated in a WebGIS system, making it easy to visualize the spatial results of the rankings. Nevertheless, MPEs have not explicitly considered spatial factors such as accessibility distance or population density, which are often key considerations in classic GIS-based location-allocation models. Therefore, the use of MPE in the context of equitable distribution of health facilities needs to be complemented by additional spatial analysis so that the results obtained are more representative of the geographical conditions and population distribution in the study area. Weight is determined based on the perception of urgency and the role of each health worker. General practitioners (4) have a large curative burden, followed by dentists (3), midwives (2), and nurses (1). Sensitivity analysis was performed by changing the weight by 10–20% and monitoring the change in the MPE rating. The results show that the sub-district rankings tend to be stable, especially in the extreme positions (highest and lowest), showing that the model is quite robust

Development

At this stage of construction, the system is designed using the QGISWEB platform. The languages used by this system are JavaScript (JS) programming languages, *Hypertext Preprocessor* Programming (PHP), *Cascading Style Sheets* (CSS), the system can be run using *an offline server* using the XAMPP control panel.

FINDINGS AND DISCUSSION

Planning

Data Collection

At this stage, a data search is performed. The data needed is secondary data. Secondary is data that already exists and has been collected by another party or from other sources. The following data were obtained in this study.

1. Data Seconds

   a. Data was obtained from the Central Statistics Agency (BPS) of Bogor Regency in 2021. Although the 2021 data is used, it is the most complete data publicly available at the time of data collection. The researcher is aware of the dynamics of the distribution of health workers post-COVID-19 and recommends regular system updates to keep the results relevant to policy relevance

2. Data Seconds

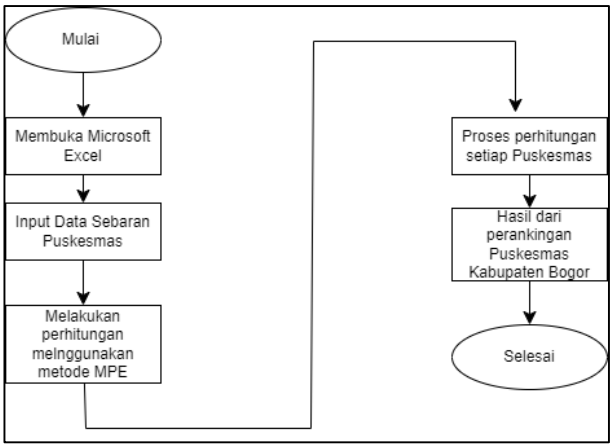
   b. In the form of Shapefile (SHP) data for the boundaries of Bogor Regency.

Modeling

Data Processing and Analysis

Data processing and analysis are data used by the Central Statistics Agency (BPS) 2021. For the data processing and analysis flowchart, it can be seen on Figure 2 below.

Figure 2: Analysis flow



Manual Calculation of MPE Method

Furthermore, the calculation is carried out using the MPE method. To perform the calculation using the MPE method, it starts by determining the criteria and the level of importance of the criteria (weight). For the weights of criteria and criteria, refer Table 2.

Table 2: Weighting criteria

No	Criterion	Code	Weighting criteria
1	General practitioner	K1	4
2	Dentist	K2	3
3	Midwife	K3	2
4	Nurse	K4	1

After determining the trend of each criterion, then a calculation is carried out to get the MPE value for each alternative which will later be calculated with the MPE approach, the calculation begins by looking for the MPE value by calculating the Total alternative value. To get the Total Alternative Value, all the values that have been obtained will be added together

Calculation of Transformation Value

After using the MPE approach, the total results of the alternative values and also the ranking results can be seen as shown in Tables 3-4 below.

Table 3: Results and rankings

No	Health Center	MEP	rank
1	Cibinong	23417	1
2	Sukaraja	15980	2
3	Lewiliang	5485	3
4	Ciampea	5340	4

5	Gunung Putri	5334	5
6	Bojong Gede	5225	6
7	Babakan Madang	4492	7
8	Cibungbulang	4441	8
9	Jasinga	4033	9
10	Dramaga	3614	10
11	Citereup	3464	11
12	Kemang	3284	12
13	Cileungsi	3118	13
14	Citeureup	3002	14
15	Tenjolaya	2637	15
16	Leuwisadeng	2603	16
17	Rumpin	2161	17
18	Parung Panjang	2151	18
19	Jonggol	2045	19
20	Cigudeg	1722	20
21	Ciseeng	1601	21
22	Caringin	1481	22
23	Tenjo	1445	23
24	Gunung Sindur	1375	24
25	Parung	1359	25
26	Cariu	1289	26
27	Sukamakmur	1173	27
28	ciawi	1167	28
29	Ranca Bungur	1120	29
30	Cijeruk	1085	30
31	Suka Jaya	1058	31
32	Pamijahan	1009	32
33	Nanggung	802	33
34	Klapa Nunggal	762	34
35	Tajur Halang	755	35
36	Tanjungsari	624	36
37	Tamansari	577	37
38	Cisarua	411	38
39	Megamendung	353	39
40	Cigombong	320	40

Cibinong, as an administrative center, has the highest concentration of health facilities, which has an impact on MPE scores. On the other hand, rural areas experience limited access, manpower, and facilities. This inequality needs to be addressed through spatial-based interventions and affirmative policies. The absence of dentists in several sub-districts can be caused by low work incentives in these areas and uneven distribution by the Health Office. This poses challenges in basic dental health services

Health Worker Adequacy Index

This table is the adequacy of health workers in each sub-district in Bogor Regency. Results from the calculation of Table 4 aims to obtain an adequacy index from general practitioners, dentists, midwives and nurses in each sub-district in Bogor Regency.

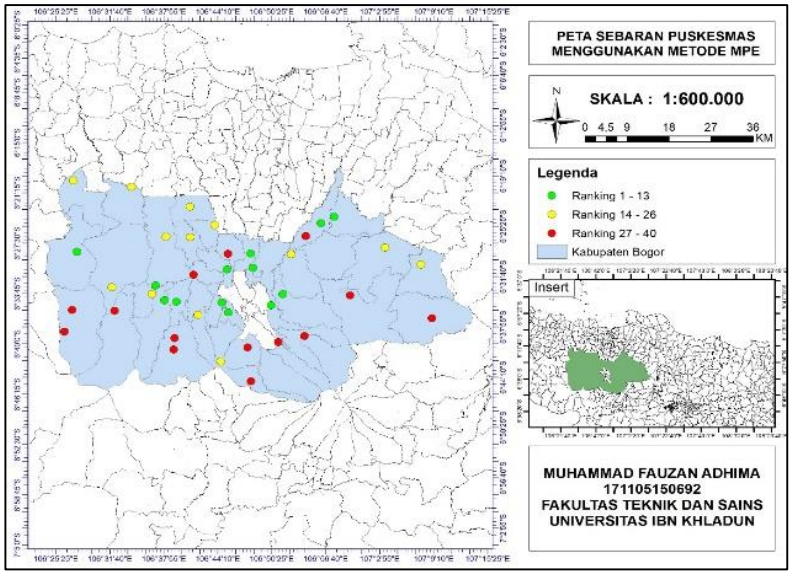
Table 4: Adequacy of health workers

No	Name of The Health Center	Sum Inhabitant	Ratio Doctor Usual	Ratio Dentist.	Ratio Midwife	Race Nurse
1	Cibinong	366403	0,03	0,08	0,07	0,02
2	Sukaraja	209415	0,05	0,11	0,09	0,03
3	Leuwiliang	125552	0,06	0,12	0,15	0,04
4	Ciampea	170206	0,05	0,04	0,10	0,04
5	Gunung Putri	301397	0,03	0,10	0,06	0,02
6	Bojong Gede	292465	0,03	0,08	0,06	0,02
7	Banbakan Madang	115575	0,07	0,19	0,08	0,03
8	Cileungsi	292163	0,02	0,03	0,08	0,02
9	Jasinga	107493	0,07	0,14	0,19	0,09
10	Cibungbulang	147554	0,05	0,15	0,12	0,08
11	Citeureup	215824	0,03	0,10	0,07	0,02
12	Ciomas	172336	0,04	0,13	0,08	0,04
13	Kemang	105937	0,07	0,21	0,12	0,05
14	Darmaga	111112	0,06	0,13	0,11	0,06
15	Tenjolaya	64428	0,11	-	0,12	0,07
16	Leuwisadeng	77871	0,09	-	0,09	0,03
17	Cigudeg	135373	0,04	-	0,14	0,05
18	Rumpin	147432	0,04	0,05	0,10	0,04
19	Parung Panjang	118727	0,05	0,13	0,11	0,04
20	Cijeruk	92838	0,05	0,08	0,18	0,03
21	Ciawi	115816	0,04	0,13	0,13	0,03
22	Ranca Bunugur	61733	0,08	0,24	0,23	0,05
23	Jonggol	145402	0,03	0,10	0,10	0,08
24	Caringin	132480	0,04	0,11	0,10	0,04
25	Suka Jaya	67988	0,06	-	0,24	0,09
26	Nanggung	99812	0,04	-	0,16	0,04
27	Gunung Sindur	129162	0,04	0,12	0,09	0,04
28	Tenjo	73845	0,07	0,10	0,16	0,07
29	Sukamakmur	86526	0,06	0,09	0,13	0,05
30	Parung	123872	0,04	0,12	0,08	0,04
31	Pamijahan	159236	0,03	0,09	0,09	0,03
32	Ciseeng	111626	0,04	0,13	0,09	0,06
33	Klapa Nunggal	131019	0,03	0,11	0,09	0,03
34	Cariu	52063	0,08	-	0,21	0,18
35	Cigombong	98388	0,02	0,08	0,14	0,04
36	Tajur Halang	126099	0,03	0,06	0,08	0,02
37	Megamendung	107945	0,03	0,14	0,10	0,02
38	Cisarua	128310	0,02	-	0,07	0,02
39	Tamansari	110481	0,03	0,14	0,07	0,03
40	Tanjungsari	57632	0,05	0,13	0,13	0,09

Processing Results in ArcGis

The results of the distribution map of health centers in Bogor Regency use the MPE method. The following is Figure 3, which is a map of the Distribution of Health Centers in Bogor Regency showing 40 sub-districts with very high and very low rankings.

Figure 3: Map of the distribution of health centers using the MPE method



Context Diagram

A Context Diagram is a process that describes the scope of a system. A Context Diagram is a diagram that describes the process of a system that is created, a diagram used to establish context and constraints About Us on the model. The context is shown in Figure 4.

Figure 4: Context diagram

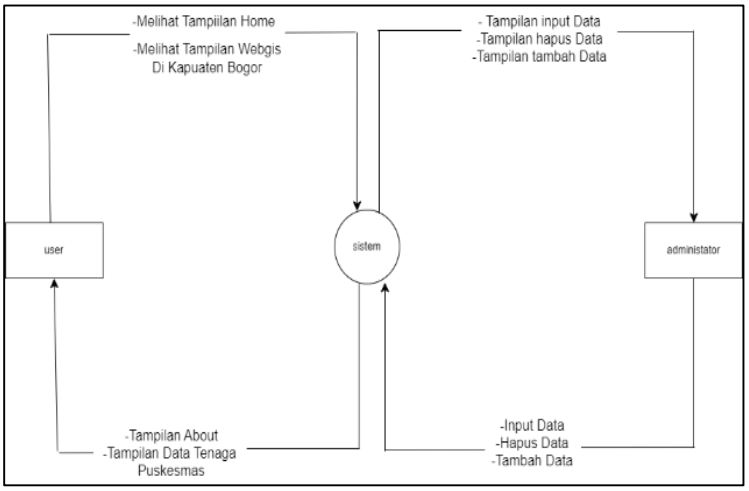


Diagram Use Case

Chart Use cases describes the actor's activity when performing an activity on a system. As for the diagram Use cases shown in Figure 5.

Figure 5: Use case

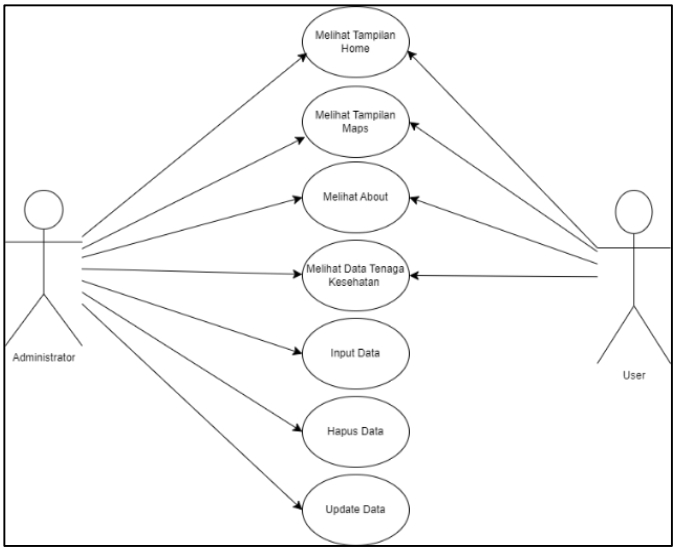
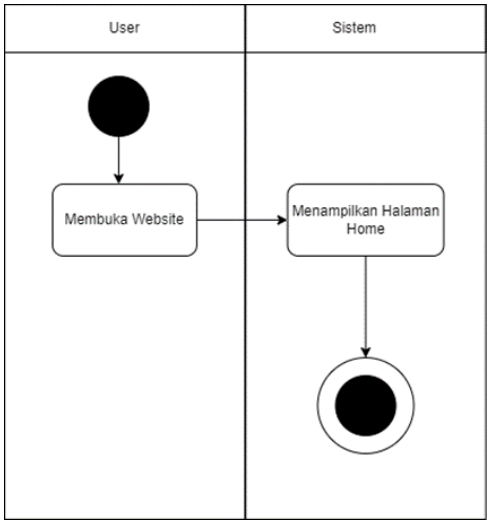


Chart activity

This diagram illustrates the process of the activity flow – the activities available in the system being designed. The Activity Chart explains how the activity starts, Activity map diagram that explains the process when carrying out the function to see the map of the distribution of the performance of the Health Center in Bogor Regency and what are the possibilities of depicting activity diagrams that can be done in About Us.

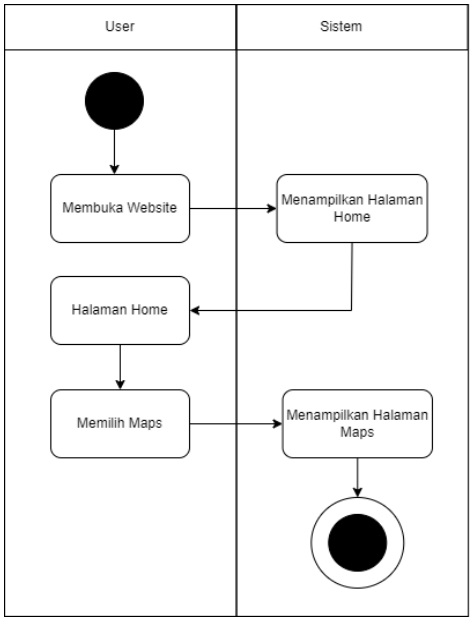
a) A diagram of the activity of users viewing login pages in WebGIS is shown in Figure 6.

Figure 6: Activity chart of users viewing home page



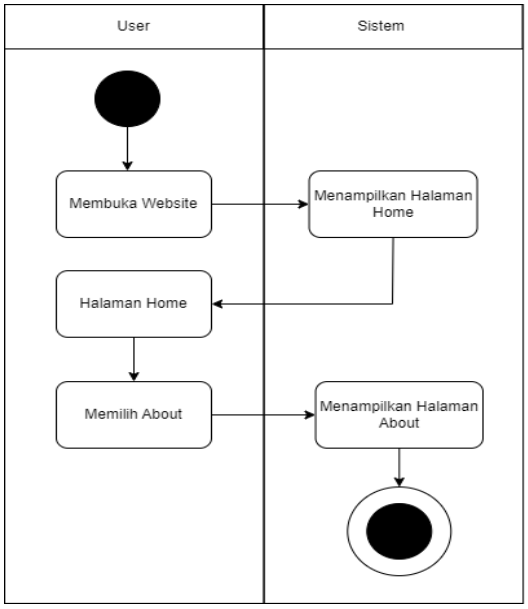
b) A diagram of the activity of users viewing a map page in WebGIS is shown in Figure 7.

Figure 7: Activity chart user viewing page map



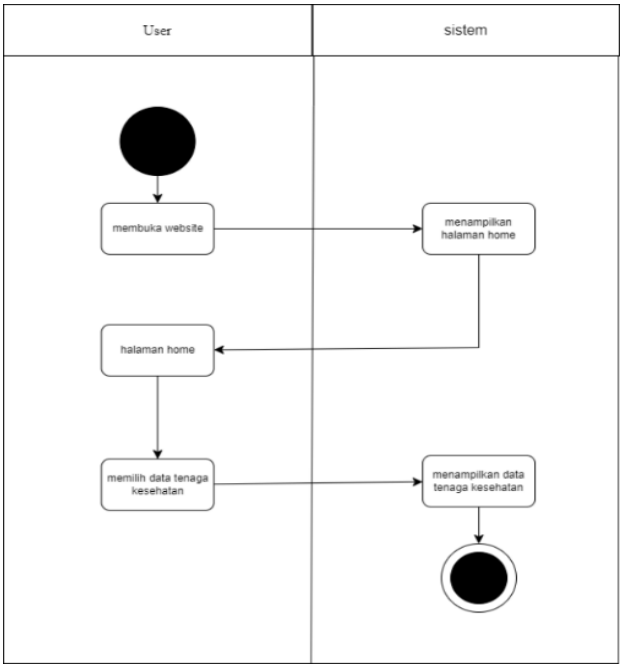
c) A diagram of the activity of users viewing the about page in WebGIS is shown in Figure 8.

Figure 8: Activity diagram user view about page



d) A diagram of user activity from the health center performance data page in WebGIS is shown in Figure 9.

Figure 9: A user activity chart viewing the health center performance page

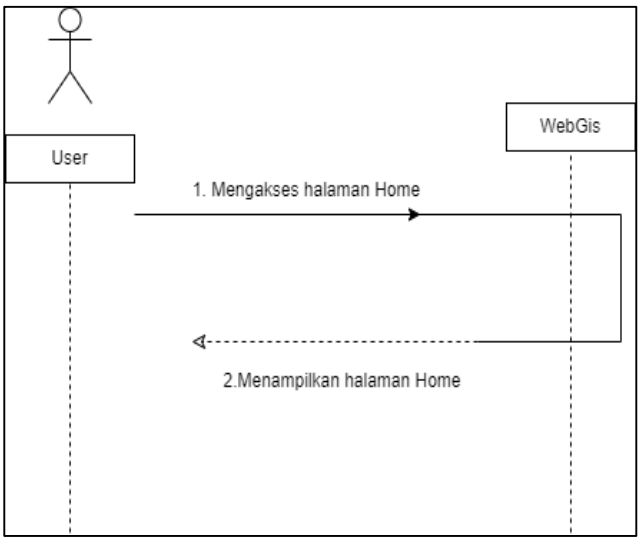


Sequence Diagram

Order Diagrams are interactions between objects in a system and communication occurs in the form of messages and time parameters. In addition, the sequence chart will also show the message or command that was sent, along with its execution time. Objects related to the course of the process are usually sorted from left to right.

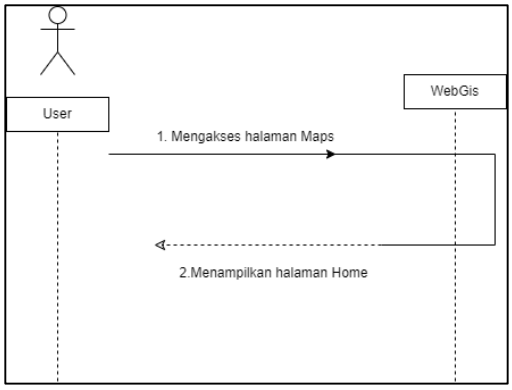
a) A sequential diagram of users for viewing the home page is shown in Figure 10.

Figure 10: Sequential chart of users viewing the home page *view*



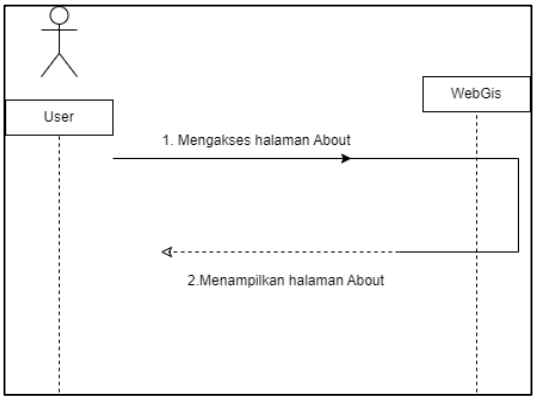
b) Sequential diagrams of users viewing the page map are shown in Figure 11.

Figure 11: Sequential diagram of the map page viewed by the user



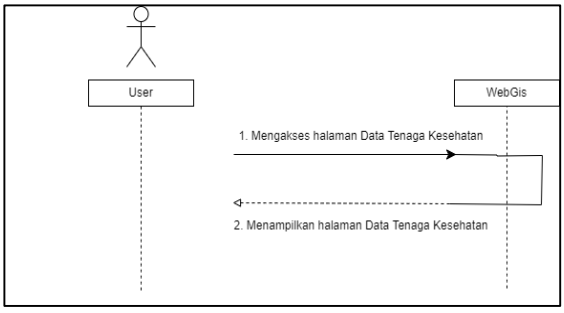
c) Sequential charts of users viewing about the page are shown on 12.

Figure 12: Sequential chart of users viewing the about page



d) The sequential diagram of users sees the data page of health workers at the health center in Figure 13.

Figure 13: Sequential diagram of users looking at data pages of health workers at health centers



Development

Application Design

Application Design Using Open Source visual studio with a language recognized by the system, i.e. Programming Hypertext Preprocessor (PHP), Cascading Style Sheet (CSS), the system can be run using

an offline server using XAMPP Panel Control, and can by using Google Chrome or Microsoft Edge, The following is a view of the website.

1. Home Page Display

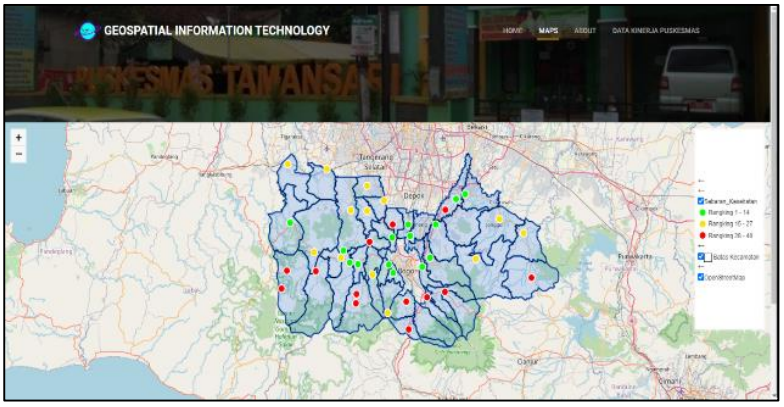
The Home page Interface view displays the website page that contains the title. For the home page view, it can be seen as shown in Figure 14.

Figure 14: Show home page interface

2. Map Page View

The Map page interface displays, displaying a website page containing a map of the distribution of Health Center in Bogor Regency. For the map page interface, you can see Figure 15.

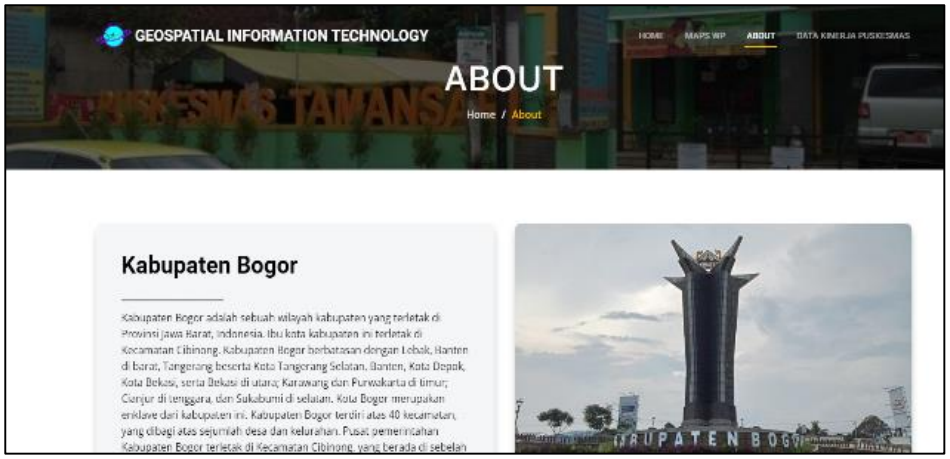
Figure 15: Map page interface view



3. About Page Visits

The interface of the about page, displays a website page containing information about Bogor Regency and the performance of the Health Center. For the about page interface view, you can see it as shown in Figure 16.

Figure 16: Interface view of the page about



4. Health Center Performance page view

The interface display of the Performance Health Center page, displaying the website page containing the Performance Health Center Data Table. For the display of the Performance Health Center page interface can be seen as shown in Figure 17.

Figure 17: Interface display of health worker data pages at health centers

CONCLUSION

Based on the results of the study, Cibinong, Sukaraja, and Gunung Putri Health Centers ranked at the top based on MPE calculations, which shows that the number of health workers is higher than health centers in other sub-districts. On the other hand, the results of the analysis showed that the lowest MPE was found in the Cisarua, Megamendung, and Cigombong Health Centers. The MPE method also shows that Cibinong Regency obtained the highest MPE score, which is 23,417. Based on classification, green includes ranks 1–13, yellow ranks 14–26, and red ranks 27–40. Based on this conclusion, the author provides suggestions for the development of Health Center in Bogor Regency, namely improving the quality of Health Center services that are still not good so that their performance is maximized, utilizing the results of this study for the development of related knowledge, and adding data on the number of general practitioners, dentists, midwives, and nurses from other 24-hour hospitals and clinics for the calculation of the adequacy ratio of health workers.

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