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The Development of Web-Based Geographic Information System for Leprosy Prevention Program in Jember Regency in 2019

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ABSTRACT

Leprosy is a chronic granulomatous infectious disease caused by the obligate intracellular organism Mycobacterium leprae. It affects mainly the skin and peripheral nerves. Moreover, it can cause severe physical disabilities and abnormalities. Jember Regency has not reached the Leprosy Elimination status until 2019 because the prevalence rate was still above 1 per 10,000 population. Based on data from the District Health Office of Jember, the findings of leprosy cases in Jember Regency fluctuate every year. The research objective in developing a web-based Geographic Information System was to display information on visualization of leprosy cases; therefore, it could become the basis for policy considerations for leprosy prevention efforts in Jember Regency. The research method was a Rapid Application Development (RAD) system. The research data and information were collected through interviews and document review. This system was designed for helping users have more accessible access to input data and automation of processing into information for users and visitors. Epidemiological interpretation of leprosy on a visual map could determine the magnitude of the case problem and Primary Health Care's reach in leprosy prevention.

Keywords: geographic information system (GIS); elimination; leprosy

INTRODUCTION

Background

Leprosy is one of the infectious diseases that cause very complex problems. The problems not only occur on a medical issue but also extend to social, economic, cultural, security, and national security issues[(1).] The number of new cases of leprosy globally in 2015 was around 210,758. Most of these cases were found in the Southeast Asia regions (156,118), followed by the Americas (28,806) and Africa (20,004), while the others were found in other regions. The highest number of new cases was found in India with 127.326 (60.4%) cases, followed by Brazil with 26,395 (12.5%) cases, and Indonesia with 17,202 (8.16%) cases. In terms of prevalence, Indonesia has achieved elimination, with a prevalence of 0.70 cases/10,000 population in 2000. Furthermore, the prevalence at 0.74 cases/10,000 population has been eliminated until 2018. However, there were still nine provinces whose prevalence has not reached elimination (<1/10,000 population), with the highest being in West Papua Province, namely 16.3/10,000 population[(2)].

In 2017, East Java Province achieved the Leprosy Elimination status, with a prevalence rate below 1/10,000 population. However, the case-finding rate was still above the national target of 6.84/100,000 population until 2018, which meant that the potential for case finding was still very possible. In the same year, the proportion of level II disability was still high at 10.4%, level I disability was at 14%, and level 0 disability or without a disability was at 75.6%. This fact was still a problem because the national target for people without disabilities should be higher than 90%[(1)]. Based on data from the District Health Office of Jember, Jember has never achieved elimination status so far. If seen from the trend of leprosy cases from year to year, there has been a decrease in leprosy case findings. In Jember Regency, 397 cases were found in 2011, which gradually decreased and rose again in 2016. Active case finding efforts could increase the number of proven case findings in 2016. The trend of subsequent cases fell and rose again; until as many as 272 cases were found in 2019. Currently, Jember has not reached leprosy elimination status because the prevalence rate was 1.13/10,000 until 2019.

As a basis for achieving Leprosy Elimination at the provincial level in 2019 and the district or city level in 2024, The Ministry of Health issued The Regulation of The Minister of Health No. 11 of 2019 concerning Leprosy Management. The regulation states four prevention and control efforts in the context of controlling leprosy, namely; (1) health promotion, (2) surveillance, (3) chemoprophylaxis, and (4) management of people with leprosy[(1)]. Surveillance activities which include recording and reporting, are directed at finding people with leprosy, treating them early, and knowing the magnitude of the problem in an area. An excellent surveillance base relies on good quality data to strengthen health information systems. Additionally, the ideal health information system should be case-based and allow reporting by all health services. It includes private providers involved in leprosy programs for reporting through sorting

data based on the geographic area, gender, age, country of origin, city/rural. Hence, it is possible to analyze the risk factors/ groups susceptible to leprosy[3].

The health information system, especially in the leprosy control program, has not run optimally. Disability activities and program reporting were reported by the Primary Health Care to the Health Office once every three months (quarterly) using reporting forms which were then summarized into a Microsoft Excel file. The application of geographic-based information systems has also not been carried out optimally in Primary Health Care. Case mapping was done manually using software without being based on actual coordinates; thus, the map accuracy got a low value geographically. Nevertheless, case mapping was vital in determining index cases for further new case discovery interventions. Thus, system data quality should minimize errors and ensure good data to inform policymakers[3,4,5].

Purpose

The purpose of this study was to manage, analyze, and present data link to geographic locations, then could enable the creation of maps and present data in the Jember regency, then it could visualize, build relationships, and analyze various features by displaying the exact location.

METHODS

This research used a descriptive analysis research design with a qualitative approach using the Rapid Application Development (RAD) system development method. The qualitative approach used interviews using interview guidelines (primary data) and observation guidelines. In contrast, secondary data was obtained from the documentation of program reports and published processed data related to this research.

The information system development method used a structured approach with several stages. These stages consisted of Requirements Planning, Rapid Application Development (RAD) Design Workshop, and Implementation. At the Requirements Planning stage, the users and the analysts or the researchers played a role in developing this information system by meeting and discussing the application or system objectives. The objectives were made by identifying several information requirements for some purposes. At the RAD Design Workshop stage, the design and improvement of the system were carried out on an ongoing basis, as referred to as a workshop. In the Implementation phase, programming/coding, testing, and system documentation were carried out.

This research was conducted in Jember Regency from August to September 2019, involving four informants. The informants were obtained based on a purposive (non-probability) sampling technique according to qualitative research design's principles, namely suitability and sufficiency. The selected informants had relevant knowledge and experiences related to this research and were sufficient. Therefore, the information obtained was complete. The key informants in this research were directly involved with the leprosy program in Jember Regency, including; Head of the Diseases Prevention and Control (P2P) Division, the Head of the Infectious Diseases Prevention and Control (P2PM) Section, and two Deputy Supervisors (*Wasor*) for the Leprosy program within the District Health Office of Jember. This research has earned Ethic committee approval that is issued by faculty of dentistry's ethic committee.

RESULTS

Jember is geographically located at 113°15'47"-114°02'35" East Longitude and between 7°58'06"-8°33'44" Southern Latitude. Jember Regency is a part of East Java Province. The land area is 3,293.34 km^2 consisting of 31 sub-districts and 248 villages. The health sector is divided into 50 Primary Health Care areas. In addition, Jember Regency has some boundaries, such as Bondowoso Regency (in the north), Lumajang Regency (in the west), the Banyuwangi Regency (in the east), and the Indian Ocean (in the south).

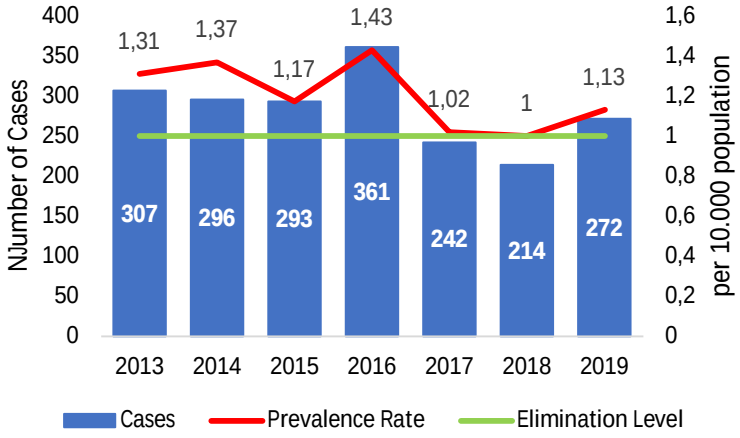

Figure 1. Prevalence Rate and Number of New Leprosy Cases in 2013 – 2019

An area is said to have reached the Leprosy Elimination status when the prevalence rate or the number of cases was below 1 per 10,000 population[6]. Until 2019, Jember Regency has not achieved the Leprosy Elimination status yet because the prevalence rate was still above 1 per 10,000 population. Based on data from the District Health Office of Jember, the findings of leprosy cases in Jember Regency fluctuate every year. The distribution of cases of leprosy per year can be seen in Figure 1. From 2013 until 2019, the prevalence rate tended to decrease except in 2014, 2016, and 2019 where the prevalence rate increased compared to the previous year. The increase

in cases was in line with early detection/intensification of leprosy case findings. The sooner cases were found, the sooner they could break the chain of transmission and prevent disability in leprosy patients.

Table 1. Data on leprosy in Jember Regency from 2017 to 2019

No	Primary health care	Year					
		2017		2018		2019	
		PB	MB	PB	MB	PB	MB
1	Kencong		2		3		4
2	Cakru		2				2
3	Gumukmas		19		3		11
4	Tembokrejo		1		2		1
5	Puger	1	3	1	5	1	6
6	Kasiyan	3	6	1	4	2	16
7	Wuluhan		3	1	4		4
8	Lojejer	1	6		5	2	6
9	Ambulu	2	3		3	1	2
10	Sabrang		2	1	1		
11	Andongsari		2		2		2
12	Tempurejo	2	7	1	11		10
13	Curahnongko		4		5		11
14	Silo I		1		1		3
15	Silo II				1	1	1
16	Mayang		3		1		7
17	Mumbulsari		13		11		10
18	Jenggawah	3	4	1	5	3	4
19	Kemuningsari Kidul		9		7		4
20	Ajung	2	13		14		10
21	Rambipuji		3		3		3
22	Nogosari		6	1	2		7
23	Karangduren		3		7	2	4
24	Balung	1	15	3	3		11
25	Umbulsari		13		16		14
26	Paleran		1		6		7
27	Semboro		5		5	1	4
28	Jombang		6		3		3
29	Sumberbaru	1	12	1	11	1	20
30	Rowotengah	4	16	2	13	1	15
31	Tanggul	1	9		8	2	5
32	Klatakan		4				5
33	Bangsalsari	1	5		2	2	5
34	Sukorejo		6		4	1	4
35	Panti		3		4		
36	Sukorambi				3		1
37	Arjasa		1				1
38	Pakusari		2		2		1
39	Kalisat		6		5	3	10
40	Ledokombo		3		2	1	1
41	Sumberjambe		1				
42	Sukowono		2		1		1
43	Jelbuk		2				2
44	Kaliwates		2		1		2
45	Mangli				2		1
46	Jember Kidul						1
47	Sumbersari		5		3		1
48	Gladak Pakem		3	1	4	1	4
49	Patrang		1		1		2
50	Banjarsengon				2	1	2
	Total	22	238	14	201	26	251

Source: District Health Office of Jember in 2019

Based on these data, in 2019, the highest number of cases from 2017 to 2019 was 277 cases. Furthermore, there were 260 cases in 2017 and 215 cases in 2018. The highest number of cases at the Primary Health Care level was 21 new cases at the Primary Health Care of Sumberbaru in 2019, 20 cases at the Primary Health Care of Rowotengah in 2017, and 19 cases at Primary Health Care of Gumukmas in 2017. The Primary Health Care that almost did not find any or few cases were the Primary Health Care of Sumbersari and the Primary Health Care of Jember Kidul, which only had one case from 2017 to 2019.

Requirements Planning

Requirements Planning is a phase of users and analysts or researchers who played a role in this information system development meeting and discussed to identify the objectives of the application or system that was made by identifying some of the information requirements needed from those objectives[7]. The data obtained from users was sourced from the Leprosy Reporting Information System (SIPK) in the form of Microsoft Excel format used by users. This Ms. Excel SIPK format was usually reported quarterly to the Provincial Health Office of East Java, then forwarded to the Ministry of Health. Seeing that there were still cases of leprosy in Indonesia, especially in Jember Regency, which contributed the highest five new cases every year. However, there were no reports in a web-based geographic information system that could map cases to make relief efforts right on target. This background made the researchers find solutions by creating a geographic information system. The SIPK data and

the interview results were used as the basis for needs analysis in the Requirements Planning phase. According to Faqih and Avisha (2019), in this stage, the description of making geographic information systems consisted of functional requirements analysis and system requirements analysis[8].

1. Functional requirements analysis
   Functional requirements analysis was divided into user requirements analysis and system requirements analysis. The requirement for a Geographic Information System (GIS) for the spread of the disease was that there should be two users who interacted with each other in the system environment, namely users (the people in charge of the leprosy program) and visitors (or community). The system requirements analysis contained the requirements, features, appearance of the information system required and expected by the users.
2. Non-functional requirements analysis
   Non-functional requirements analysis related to the requirement for processes given to software that would be designed outside the website's primary functions, such as technical operations and website and database security.

RAD Design Workshop

This stage translated software requirements from the requirements analysis stage to the design representation implemented into the following program. The software design produced at this stage also needed to be documented[9]. The process of designing a web-based geographic information system for mapping leprosy cases took some steps, including:

Flowchart System Design

The system flowchart design was made based on the flow of the system to be made. The application used to create flowcharts for this system was Microsoft Office Visio 2010. The design of this geographic information system had two types of system flowcharts, namely System Admin Flowcharts and System User Flowcharts. The following are System Admin Flowcharts and System User Flowcharts in the design of geographic information systems for mapping leprosy cases in Jember Regency:

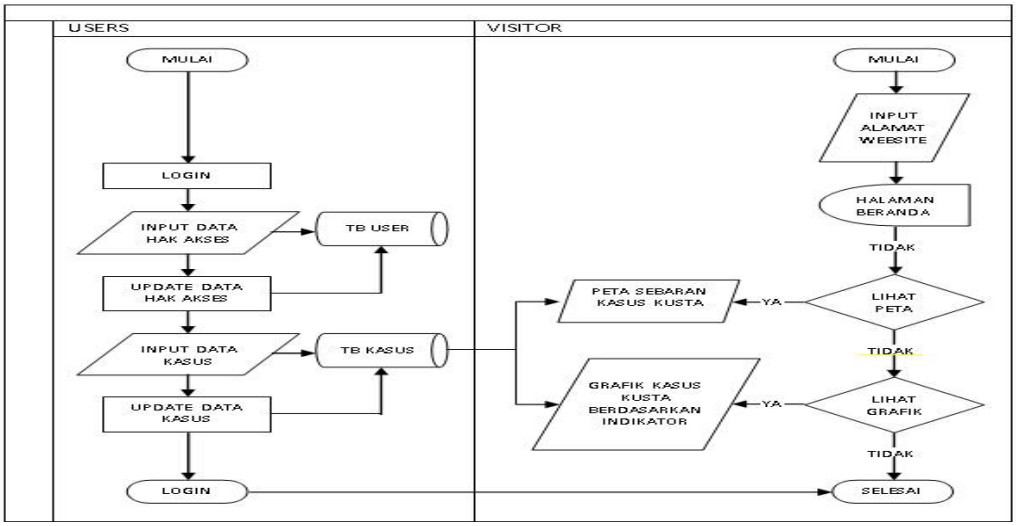

Figure 2. Flowchart system

Flow Diagram Data

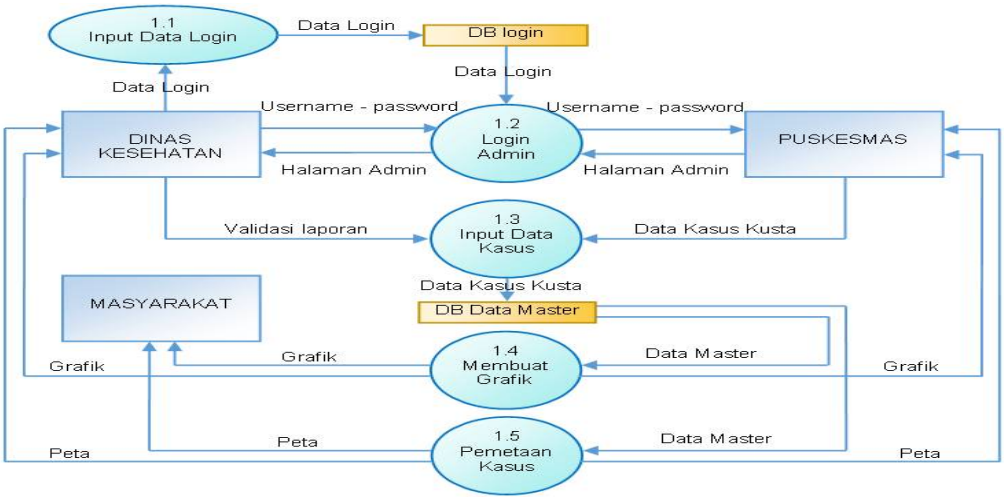

Figure 3. Level 1 flow diagram data (DFD)

Figure 3 was a Level 1 DFD of a Web-Based Geographic Information System for distributing leprosy cases in Jember Regency. The level 1 DFD resulted from the decomposition of the primary process of the Context Diagram to describe the processes in more detail in this geographic information system. The Level 1 DFD consisted of two entities, two data stores, and five processes.

Entity Relationship Diagram

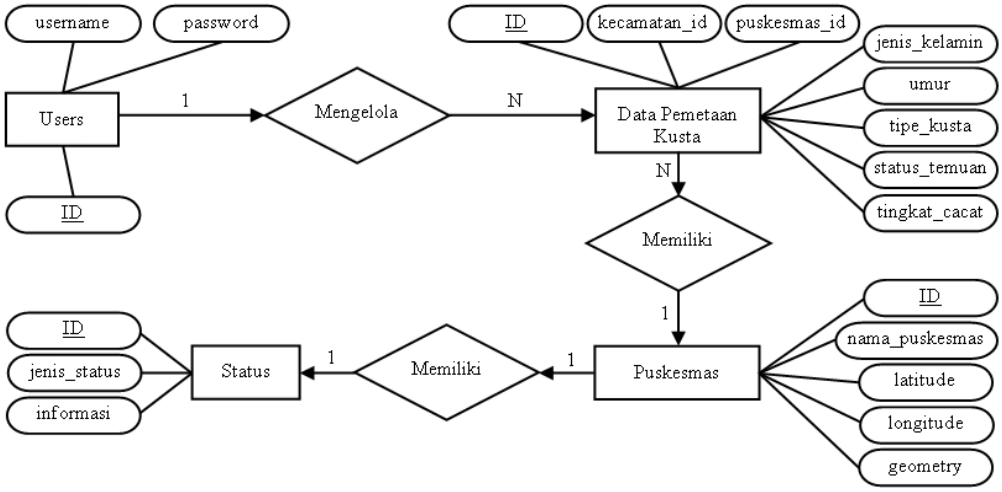

Figure 4. ERD web-based GIS leprosy

Figure 4 depicted an ERD of a web-based geographic information system for leprosy cases spread in Jember. In the ERD above, there were four entities, namely users entities, mapping data entities, Primary Health Care entities, and status entities. Moreover, the relationships in the ERD on the Leprosy Web-based GIS of Jember Regency included the relationship between users and mapping data, the relationship between Primary Health Care and mapping data, and the relationship between Primary Health Care and status.

Geographic Information System Table Design

The table design on the geographic information system for the leprosy cases spread based on the Google Maps API integrated website in Jember Regency consisted of three tables, namely the users' table, the mapping data table, the Primary Health Care table, and the status table.

Coding

The next stage was coding the system design made into a programming language. Designing a website-based geographic information system for leprosy was adapted to the needs of data and information obtained from the interview results conducted and concluded.

Implementation

In this stage, the analyst worked with the users intensely during the workshop and designed the technical and non-technical aspects of the company/organization. Once these aspects were approved and systems were built and screened, new systems or parts were tested and then introduced to the organization[7]. After carrying out a series of design stages, the next stage was implementing the information system, and system testing was carried out with the results as in Table 2.

Table 2. Testing the web-based geographic information system

No	Functionality	Testing scenario	Expected results	Conclusion
1	Being able to load page	Entering the website page via *localhost*	A web page appeared containing the home menu, map of the number of patients, graphs, and number of patients	Succeed
2	Being able to log in to the admin dashboard page	Entering the admin's username and password	Entering the admin dashboard page with the user guide menu, patient data entry, access rights, and view front page	Succeed
3	Being able to use the access rights menu	Clicking the access rights menu	The access rights page appeared to add, change, and delete access rights data	Succeed
4	Being able to use the case report entry menu	Clicking the patient data entry menu	Showing page for new leprosy patient entry	Succeed
5	Being able to use the menu view the front page	Clicking the front page menu	Showing home page containing kie	Succeed
6	Being able to display a map of the distribution of leprosy	Clicking menu	Showing information containing maps along with info windows of data that had been entered into the system	Succeed
7	Being able to use the leprosy spread statistics menu	Clicking the leprosy spread statistics menu	Showing information containing data on leprosy cases that had been entered into the system in the form of graphs and diagrams	Succeed
8	Being able to use the leprosy distribution table menu	Clicking the leprosy distribution table menu	Showing information on leprosy patients per district	Succeed
9	Being able to logout (exit) to the admin dashboard page	Clicking the exit button	Logging out of admin page	Succeed

DISCUSSION

Specific policies regarding the countermeasures of leprosy are stipulated in the Regulation of the Minister of Health of the Republic of Indonesia Number 11 in 2019 concerning Leprosy Countermeasures. Article 21 states that human resources (HR) involved in the implementation of leprosy countermeasures are health workers who have competence in accordance with predetermined criteria and requirements and can also involve trained people. The existence of human resources will affect the organization's efforts to achieve goals so that the better available human resources, it is hoped that the efforts to organize a program can also run more optimally[10].

Based on the interviews that have been conducted, human resources in the implementation of the "Jember Sikat Habis Kusta" program involve various stakeholders such as doctors, nurses, health educators, cadres, village midwives, religious leaders and community leaders, laboratories, and people who have experienced leprosy (OYPMK). The involvement of these stakeholders must act in accordance with their respective capacities in supporting program activities to be carried out according to the Decree of Indonesian Republic Minister of Health Number 11 in 2019 concerning Leprosy Countermeasures which includes:

1. Leprosy program managers must receive training on leprosy countermeasures
2. Health workers at Puskesmas (at least doctors and nurses) have been socialized about the leprosy program
3. Health cadres, religious and community leaders, and OYPMK have received socialization regarding the leprosy control program

The success of leprosy countermeasures is determined by the availability of adequate human resources both in terms of quality and quantity, because the better available human resources in a program, the more people will feel comfortable and willing to be involved in the various programs held. One of the things needed to maintain the quality of human resources is through capacity building. Capacity building activities for each implementing party involved are related to the knowledge, abilities, and skills of implementers so that they can increase optimization in every activity carried out. Not only that, there needs to be strong cooperation, synergy, and mutual commitment to jointly eradicate the problem of leprosy that occurs. The importance of training implementation is also useful so that human resources who have leprosy really understand and can be responsible for eliminating leprosy[11].

Health budgeting or health funding is defined as the amount of costs available for the implementation of health programs or for the use of various health efforts, both for individuals, families, and communities. The availability of the budget is a crucial aspect, especially in supporting the implementation of a program so that the existing budget must not only be available in sufficient quantities, it must also be allocated appropriately so that program implementation can run optimally. The budget for implementing the leprosy countermeasures program in Jember Regency is still relatively low. The lack of program budget has caused several activities such as training by bringing in patients, Intensifying Case Finding, and empowering Self-Care Groups (KPD) to run less optimally. However, those three activities are very important to optimize the implementation of the program.

Another encountered obstacle is the budget allocation which is still not comprehensive. The budget allocation is not yet comprehensive, especially for prevention activities such as Education Information Communication (KIE), improvement of nutrition and sanitation, and other preventive measures media to stop the transmission of leprosy. Likewise, in the case of patient discovery activities, puskesmas is still not one hundred percent taking the Leprosy Operational Assistance (BOK) funds for the leprosy program that has been provided, even though these funds can be used for patient discovery or patient follow-up. KPD empowerment activities consisting of leprosy patients and people who have had leprosy (OYPMK) are useful as a support system for fellow sufferers and as a forum for sharing experiences for OYPMK. However, this group is still not running due to inadequate budget.

Bringing in patients for a training is very important for program implementers in the field to know directly about how to check for symptoms and clinical diagnoses of patients. However, this kind of training activity cannot be implemented yet due to budget constraints. Training for leprosy officers is also a matter that needs to be prioritized, in this case training needs to be included in the program budget in order to maintain knowledge, skills, and thus its implementation can run in accordance with the procedure[12].

In an effort to find patients, one of them is screening activities to check for signs of leprosy in family members (self-screening). This effort is very important to identify a disease that is still not visible by carrying out a simple examination that will later be able to separate between people who have the disease or those who do not[13]. The form used for the self-examination contains two parts, namely personal data (name and address) and examination of spots and scabs accompanied by the location where the spots were found along with personal data of family members who have spots or scabs. Screening efforts on family members is an effort to empower the community to actively participate in checking for signs of leprosy that may be present in their family members. Through this screening effort, it is hoped that it can reduce disease morbidity and even prevent disability with early treatment possible.

Facilities and infrastructure are also an important component in the implementation of a program. According to research conducted by Ristiani (2017) it is stated that the quality of a service depends on the facilities and infrastructure available in the implementation of a service. Not only based on the availability aspect, but if in terms of the use of the infrastructure facilities are correct, then the facilities and infrastructure can be stated as good[15].

One of the procedures in establishing the diagnosis of leprosy is through the examination of Acid Fast Bacilli (BTA). The smear examination for leprosy in the laboratory includes 3 important examinations including bacteriological, hispathological, and immunological examinations. Bacteriological examination is useful for making a diagnosis, classifying leprosy, assessing treatment results, and knowing whether there is drug resistance, hispathological examination is used to make a diagnosis of leprosy if the clinical manifestations and results of bacteriological examination are unclear, immunologic examination is useful for knowing the classification and the course of leprosy[16].

The implementation of a program must also know who will be the target of the program and who are entitled to receive the service. In this case, the target is adjusted to the activities carried out including health promotion activities, leprosy surveillance, treatment and chemoprophylaxis, as well as rehabilitation management for leprosy patients. Therefore, it is important to know who is the target in organizing activities. Efforts to invite stakeholders through re-

socialization of leprosy control policies are needed in order to obtain bureaucratic commitment, monitoring and evaluating programs within the scope of their respective regional governments. Socialization to health workers and health cadres is also needed so that the knowledge and skills of officers can be continuously improved. As well as socialization to the community, especially to sufferers and contacts, is needed so that the community gains knowledge and understanding about preventive measures, treatment, and self-care that need to be done.

The existence of resources will optimally function, if there is a way or method to manage the available resources. This method is also useful so that the allocation of these resources can be effective and efficient so that an organization or program can run according to its objectives [(17)]. In terms of management, it is necessary to have guidelines or Standard Operating Procedures (SOP) so that the existing resource arrangements can run well. Standard Operating Procedure (SOP) is defined as a guideline that is used as a reference for the implementation of tasks based on technical, administrative, and procedural indicators in accordance with work procedures, work arrangements, and work systems in the concerned work unit. Based on the interviews, it was found that the implementation of the program has been running in accordance with the available SOP listed in the Regulation of the Minister of Health of the Republic of Indonesia Number 11 in 2019 concerning Leprosy Countermeasures. The existence of this SOP is in line with program management theory where the existence of procedural standards in a program can obtain clarity from a procedure, time efficiency, standardize all activities, and make evaluation easier (Rosalin, 2017).

CONCLUSION

The web-based geographic information system for the leprosy prevention program informed the mapping of leprosy cases in the Jember Regency. The information provided was in the form of visualization of the mapping of leprosy cases, child leprosy cases, the presence of level II disability cases, and the coordinates of leprosy patients. This system was a web-based application. It could be accessed online using a web browser. This designed system still had several weaknesses; therefore, hopefully, it could be developed by further researchers, namely, by adding a mapping based on prevalence per Primary Health Care area and mapping areas that had received prevention mass drugs administration (POPM) to be used as material for evaluating the success of leprosy prevention and control programs. In addition, further spatial analysis research could be carried out, for example, the relationship between leprosy cases and population density and mobility of leprosy patients.

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