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Geographic Information System (GIS) as an Information Media in the Field of Environmental Health: *Literature Review*

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Abstract

Geographic Information System (GIS) is a system with a collection of data that has a special capacity to combine data, coordinate data, and perform data checks that produce output to be used as a source of decision making. Geographic Information Systems (GIS) can be linked to health information at a particular location, combine, analyze and produce the health information according to activities in the health sector per location. Furthermore, the use of Geographic Information Systems (GIS) is planned to determine areas, conditions, styles, patterns and models related to the health sector. Geographic Information System (GIS) can create a map display by knowing the data from the map and other related data in presenting information about an area on the map.

Keywords: Information Media, Geographic Information System (GIS), Health Sector.

1. Introduction

1.1 Sub Introduction

The development of the times and the socio-economic progress of local communities can lead to high community activities towards the quality of health services. Activities carried out in each area for health workers will be reduced if the health office carries out health management with good quality, especially by utilizing data information technology, especially Geographic Information Systems (GIS) which can be easily accessed using the internet, especially for people who can access information on the internet. The health sector in their area of residence (Taki and Lubis, 2017)

Geographic Information Systems (GIS) in the health sector can link health information that focuses on certain areas, and combine, analyze and map the results of health information according to regional health activities. Furthermore, by applying the Geographic Information System (GIS) one can find out various areas, conditions, styles, patterns, and modeling related to the health sector (Hege et al., 2014).

The objectives of environmental health are, among others, to adjust, limit or change the occurrence of environmental hazards to health in the welfare of human life (Taki, et all, 2020). Another goal is also to anticipate and optimize the regulation of various environmental sources to improve health and develop the welfare of human life by avoiding various risks of infection. Scope of environmental health according to WHO there are 17 components in the welfare of human life. Some of them are the provision of drinking water, wastewater management and pollution control, prevention or control of soil pollution by human excreta, housing, and settlements (Beze et al, 2016).

In knowing the problems in the health sector, especially in Indonesia, several groupings are needed in conducting searches to carry out various ways to run them more effectively and efficiently (Taki and Sunandar, 2021). The grouping is determined by several factors, one of which is from various disciplines. One of the groupings of health problems, namely based on the environment and then understanding the spatial pattern, to find out the extent of the location and distribution of health problems. The spatial analysis relates to the health sector which is a combination of geography and health sciences, then to the process of geomatics and geoinformation generated from a result of spatial analysis such as regionalization of a regional problem, both formally and functionally (Endang Indriasih, 2008).

In general, in public health, Geographic Information Systems (GIS) are used to identify health problems and identify restrictions in the health sector to be more specific. In carrying out the decision-making process to carry out disease prevention strategies and conduct analysis. In general, in public health, Geographic Information Systems (GIS) are used to identify health problems and identify

restrictions in the health sector to be more specific. In carrying out the decision-making process to make efforts to prevent disease strategies and carry out the analysis.

Geographic Information System (GIS) technology today has developed rapidly. In limited use in the field of geography but has spread in various fields, especially in the health sector (Rinner et al in Rahmati and Prasetyo, 2012). In the health sector, there are various kinds of health problems that can be overcome from various disciplines but must be combined through the application of Geographic Information Systems (GIS). Geographic Information systems (GIS) can play a role in disease prevention in terms of prevention. One of the virtues of Geographic Information Systems (GIS), namely spatial clustering analysis can be used to determine the spatial distribution pattern of a problem which is then analyzed related to environmental factors. This technology can be used to determine the spatial pattern of the community health service center so as to obtain information on site selection planning in carrying out the construction of health facilities.

The development of a computerized-based Geographic Information System (GIS) through a website, it can make it easier for the public to monitor problems related to the public interest because the application of the website is easy for the general public (Beze *et al*, 2016). When presenting information geographically, it can provide an overview or from a different point of view when solving a problem. Geographic Information Systems (GIS) can be developed by combining spatial and non-spatial databases so that they can provide detailed information in solving a problem (Puteri *et al*, 2014).

Based on this background, it is possible to implement a Geographic Information System (GIS) to improve health services. At the time of processing computerized health service data and providing information about the distribution of health services as a whole to the community (Taki, *et al*, 2019). In this paper, Geographic Information Systems (GIS) in the health sector will be written as Geographic Information Systems (GIS) as information media in the field of environmental health. The application of a Geographic Information System (GIS) will make it easier to carry out an activity in the health sector.

2. Method

This study uses a literature review approach from several sources based on the criteria for the environmental health approach that have been set by previous researchers. In the literature search using various accredited journals. This process is used to improve the detail of the search results.

The method used in monitoring environmental health in Harapan Baru Village is using tools from the application of Geographic Information Systems (GIS) by utilizing data sources to analyze *spatial clustering* (Beze *et al*, 2016). There are two clustering results, as follows:

1. *Clustering* of latrine use.
2. *Clustering* the use of water sources. There are three categories used in the cluster of water sources which come from PDAM, river water, and well water.

In general, the data used in this study are spatial data and non-spatial data. Spatial data consists of three tables, namely:
1. The house coordinates data point table.
2. Road data table.
3. Data table of RT/kelurahan boundary polygons.

While the non-spatial data used are:
1. House data table.
2. Occupant data table.
3. Table of latrine data.
4. Water source data table.

In addition to these data, the system developed in this study can manage user information in the form of registration data and user level settings. The table used for user settings, as follows:
1. *User*: id, name, email, password, token.
2. *Role* : id, name, display_name, description.
3. *Permission* : id, name, display_name, description.

3. Result and Discussion

There are four parts that will be developed in the environmental health monitoring application, namely the input system, database, process, and output.

1. Input System

The input system is in the form of separate data, namely the input of spatial data and non-spatial data. Spatial data input system using Quantum GIS application. The tools used for spatial data, namely point, line, and polygon types to be managed in applying open source are stored in shapefiles and can also be stored in geoJson form.

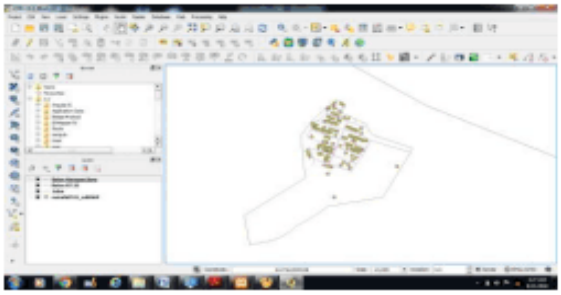

Fig 1. Example of Spatial Data Management Using Quantum GIS Application
Source: Beze *et al,* 2016

While the non-spatial data input system is processed using the Laravel framework. Each table in the form of house data, types of latrines, and water sources used by residents will be made tools for data, display data, editing and deleting data. These tools will be used based on the results of discussions with users, namely the Harapan Baru Health Center. Non-spatial data will be stored in a relational database using the MySQL application.

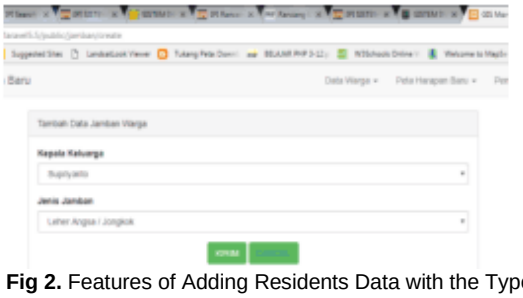

Fig 2. Features of Adding Residents Data with the Type of Latrine It Has
Source: Beze *et al,* 2016

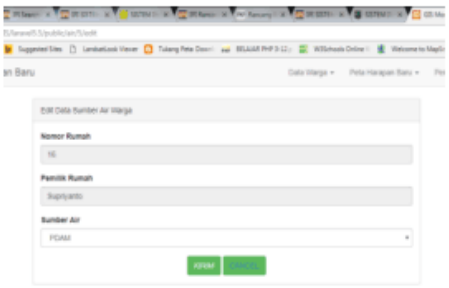

Fig 3. Edit Resident's House Water Source Data
Source: Beze *et al,* 2016

2. Basis Data

This application database was developed on the MySQL application. The database is in the form of spatial data and non-spatial data. Spatial data consists of point data of residents' houses, road maps, and polygon data types of districts boundaries. The data is saved in shapefile and geoJson formats and placed in public or data folders

Non-spatial data is developed in the MySQL application with two groups of relations.

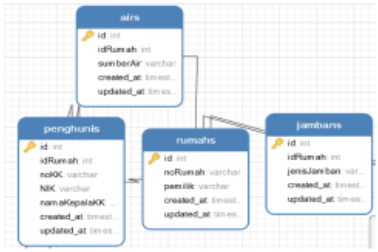

Fig 4. Physical Design of House Data, Types of Latrine and Water

Source: Beze *et al,* 2016

3. Process System

The process carried out in the development of the system, namely the processing of spatial data and non-spatial data. These two processes are intended to facilitate the development of running applications.

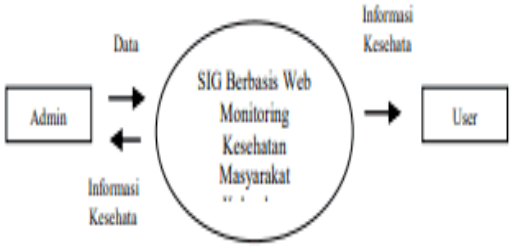

Fig 5. Web-Based GIS Context Diagram Harapan Village Community Health Monitoring New
Source: Beze *et al,* 2016

4. System Output (Output)

In the input system, the output system developed in the application is divided into two, namely the spatial data output system and the non-spatial data output system.

The spatial data output system displays household maps, maps of water sources, and maps of the distribution of latrines used by residents.

The non-spatial data output system displays house data, occupant data, water source data, and data on the type of latrine used. The data is made into tabulations.

5. GIS in Public Health

Public health in meeting the needs of the community to ensure conditions are in a healthy condition. The implementation of public health depends on three components, namely the workforce, both government and private organizations. Information and communication systems used in collecting and disseminating accurate data.

According to WHO, Geographic Information Systems (GIS) in public health can be used as:

a. Determine the geographic distribution of the disease.
b. Spatial and Temporal trend analysis.
c. Mapping of populations at risk.
d. Stratification of risk factors.
e. Assessment of resource distribution.
f. Planning and Determination
g. Intervention.
h. Disease Monitoring.

The information generated is in the form of maps of the spread of disease, graphs of survival rates (using survival analysis method) and various graphs to determine the characteristics of patient data such as graphs of the number of patients over time, bar charts of patient age distribution.

6. Implementation of GIS in Mapping the Spread of Disease

According to Prahasta (2001), Geographic Information Systems (GIS) in the health sector can be used to provide spatial data and data to describe patterns of disease spread or distribution models for health facility units including medical personnel and other health workers. Through a disease, a mapping system to find out information about the points and numbers of disease spread to make it easier to get control from related parties. This can be seen in the Geographic Information System (GIS) mapping the spread of disease using the Website-Based Google Map API derived from research results (Krisna et al, 2014).

Geographic Information System (GIS) method for mapping the spread of disease using a website-based google maps API. API as a programming function provided by applications for services so that they can be used in applications that have been created.

Google maps API is used as a programming function provided from Google maps so that it can be applied to websites or in applications that are being made for mapping the spread of disease.

An overview of the information system can be seen that administrators and users consisting of admins, users, and guest agencies related to the design of the system then enter the web server on the mapping, through the design interface the system will connect to the google map to find out the image from the map. The system will then be connected to a database to store disease data, regions, and disease cases.

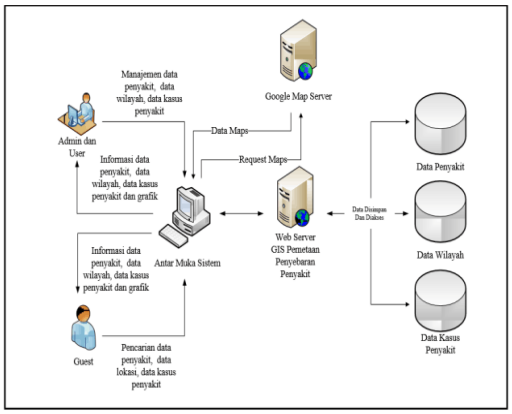

Fig 6. Overview of geographic information systems mapping the spread of disease
Source: Krisna *et al,* 2014

The system can be accessed quickly and easily. Requires an internet network and provides information on mapping the spread of the disease that can cover the territory of Indonesia. This system can display a map that contains information about the area of the case of the spread of the disease, the number of cases of the spread of the disease, and the location of the case of the spread of the disease. This system uses maker tools to find out which health agencies are registered in the system, polygon tools to find out an area including provinces, districts, and sub-districts, and circle tools to find out locations affected by a disease. This system can provide results in the form of a graph of the number of cases of the spread of the disease and information about the data displayed using the period system. Display of Geographic Information System (GIS) Mapping the Spread of Disease Using Google Map API Web-Based can be seen in Figures 7 to 10.

Figure 7 describes the main page of the disease spread information system. The map is obtained from google maps.

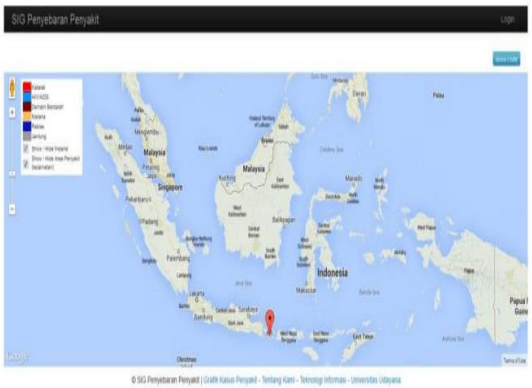

Fig 7. The main page of the disease spread information system
Source: Krisna *et al,* 2014

Figure 8. Health agency markers and info window
Source: Krisna *et al,* 2014

Figure 8 on the map has a maker explaining the location of the health agency that has been registered on the system or website. When the user clicks on the tool maker, an info window will appear containing the names, addresses, and photos of health agencies located in each province, district,and sub-district in Indonesia.

Fig 9. Menu bar search disease
Source: Krisna *et al,* 2014

Figure 9 shows the menu bar, in conducting the disease search process. In this menu bar there is filtering data, namely in the form of the start date and the date of completion of a disease, the age used in finding data that matches the user's age. The region filter can function to find out the information needed for data processing according to the region.

The filter area is divided into 3, namely the province, district, and sub-district. To filter the name of the disease which is designed by using a check box so that various types of disease data are obtained according to the needs on the map. If the check box is not checked, then all diseases displayed on the system will be displayed on the map.

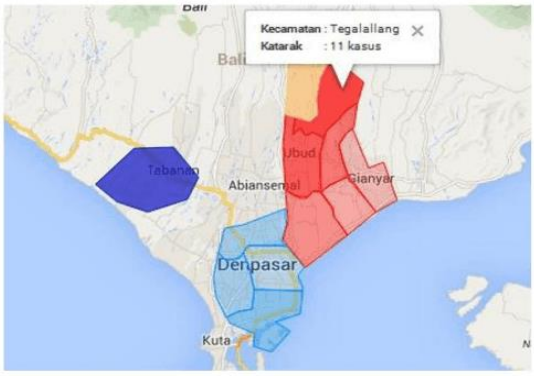

Fig 10. The appearance of polygons on the map
Source: Krisna *et al,* 2014

Figure 10 is a map display of the spread of disease using polygons and there are levels of spread cases that are distinguished from the opacity level of the polygon area. In the map view, the thicker the opacity level, the higher the number of cases of the disease. When the user knows more than 1 type of disease, the disease with the most cases will be displayed on the top layer, then the user can click on the polygon area to able to display an info window containing information on the area and the number of disease cases.

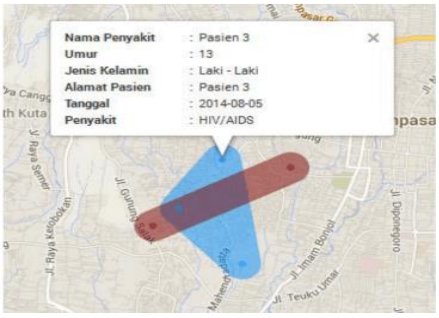

Fig 11. Display of circles on the map
Source: Krisna *et al,* 2014

Figure 11 describes the display of cases of disease spread using circles. This view is used when the user uses the disease spread view at the sub-district level or when zooming in on the map. In the data display using circles, the aim is to provide information about the spread of disease at the coordinates of the place of residence. Users will find it easier to group distribution case points because the circle is equipped with tools to find the outermost area of the collection of spread case points per sub-district.

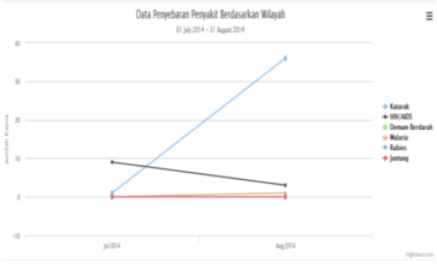

Fig 12. Graph display per month

Source: Krisna *et al,* 2014

Various kinds of health problems can be identified from one of the disciplines that can be combined, one of which is the mapping of Geographic Information Systems (GIS). Geographic Information System (GIS) plays an important role in tackling several types of diseases in terms of prevention. One of the concepts of the Geographic Information System (GIS) uses spatial clustering analysis data that can be used to determine the spatial distribution pattern of a disease and then analyze it related to various environmental factors. Geographic Information System (GIS) technology can be used to determine spatial patterns in community health service centers so that it can be carried out in site selection planning in building new health facilities (Higgs, 2005).

According to Higgs (2005), there are several examples of functions in analyzing spatial data that can be used as spatial data in analyzing information in the health sector.

a. Buffering (to determine the area coverage in an incident case).
b. Overlay analysis (to find out the specific location of the incident case).
c. Network analysis (to be used to determine the characteristics of a network, such as road maps and transportation availability, to analyze the movement or movement of resources from one location to another, for example to measure the time it takes to access health facilities).

With a variety of applications used for making close sources and open source mapping distributions such as ArcView, ArcGIS, CrimeStat, EpiMap, SatScan, GeoDa, HealthMapper, and StatPlanet and supported by increasingly advanced technologies such as google map or google earth. Geographic Information System (GIS) can be used to analyze information in the health sector statistically, it is much easier to present information in the health sector so that it is easier to communicate for related agencies to the community.

A geographic Information System (GIS) is used to manage spatial data in analyzing strategic mapping. As input for policymakers in the health sector in applying the dissemination of mapping through Geographic Information Systems (GIS) must be carried out with a multi-disciplinary team to obtain uncertain data information from the results obtained. The main objective of mapping through the application of Geographic Information Systems (GIS) is to improve the ability to plan activities in the health sector (Endang Indriasih, 2008).

4. Conclusion

The results of the study explain that the application of Geographic Information System (GIS) technology has various benefits, especially in the health sector. Geographic Information Systems (GIS) can be developed to provide the latest and most current information about the condition of health service users. In the development of a Geographic Information System (GIS) application to monitor users on the website page to make it easier for users to understand and access the information listed in the application. In the development of non-spatial databases, Geographic Information Systems (GIS) can strengthen users so that they can find out the information conveyed by the application.

Geographic Information System (GIS) is a geospatial technology that is a system for collecting, managing, and evaluating spatial data and can be used in various fields, one of which is in the field of public health, especially epidemiology. In the program of health agencies in making efforts to prevent various diseases, it will be very effectively used for users to get support from information in conducting a review of the spread of disease because the information system can provide epidemiological data that is quickly and easily obtained for changes that occur in cases of spread disease.

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