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Development of a Dengue Epidemiological Surveillance Information System for Early Aware with a Geographical Information System in the Pidie Jaya Health Service Area

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ABSTRACT

Introduction: Dengue hemorrhagic fever (DHF) is an infectious disease that often causes extraordinary events (KLB) in Indonesia. This disease has a fast disease course, spreads easily and can cause death in a short time.

Predicting the incidence of dengue hemorrhagic fever in an area has so far been carried out based on endemicity stratification, maximum - minimum patterns and 3−5 year cycle according to epidemiological surveillance data. There are weaknesses in this method of prediction due to changing data ahead of the dengue transmission season and the absence of up-to-date risk factor data, so predictions are often incorrect. DHF risk factor data can be used to determine the type of intervention, so that DHF events can be prevented according to the early warning concept.

Some of the epidemiological surveillance data produced is still processed manually and semi-automatically with limited presentation in the form of tables and graphs, while the presentation in the form of maps has not been done. Based on this fact, a DHF epidemiological surveillance system for early warning based on Geographic Information System (GIS) was developed. In this system, DHF risk factors are collected through a Rapid Survey just before the transmission season to obtain the latest data to determine the type of intervention. With GIS, risk factor maps, case maps and other activity maps can be produced, and with the *overlay technique* planning and evaluation of DHF eradication programs can be carried out.

Objectives: "How is the Development of a DHF Epidemiological Surveillance Information System Using a Geographic Information System that Can Be Used for Early Alertness in Pidie Jaya District?"

Material and Method: The research to be carried out is an *operational research* because it includes system development to be able to solve the weaknesses of the current system. The system development approach uses the FAST *(Framework for the Application of System Techniques)* method according to the FAST stages.

Result: In the last 5 years (2016− 2020), DHF cases in the Pidie Jaya health center area have continued to increase, with 32 cases recorded (2016); 72 cases (in 2017); 115 cases (in 2018); 152 cases (in 2019) and the highest in 2020 was 285 cases, 6 of them died, so that in 2016 the Health Center in Pidie Jaya was declared an Extraordinary Dengue Event (KLB) of DHF. This is different from the theory which states that the peak incidence of recurrent DHF follows a 5-year cycle, where outbreaks usually recur within 5 years. With this fact, the 5-year cycle should not be the main basis for predicting outbreaks in the framework of early warning.

The results of the analysis by person are not immediately known, because the distribution by age group has not yet been recorded in the DHF program activity report format. Likewise, the distribution by sex has also not been obtained, even though in the DP-DHF form there is an age variable, but it is often not included in reporting.

Conclusion: The DHF Epidemiology Surveillance Information System which has been running so far has many weaknesses

The DHF Epidemiological Surveillance Information System that has been running so far

has not been able to predict the possibility of a spike in cases in the context of early warning
In the preliminary study of the DHF Epidemiological Surveillance Information System, it was found that there are expectations, needs, opportunities, directions and policies that support the development of the Epidemiological Surveillance Information System.
In designing the DHF Epidemiology Surveillance Information System with GIS, a data base was built, namely Province *files* , Regency *files* , District *files* , Village *files* , Community Health Center files, *patient files* , PE files, 3M movement *files* , *PJB files* , and *rapid survey files*
Evidenced by the assessment of system performance evaluation where all respondents stated that they almost strongly agreed (overall average = 4.72). While the old system respondents said they did not agree (overall average = 1.78).

Keywords: *DHF, Rapid Survey, GIS*

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is an acute febrile illness caused by the dengue virus. This virus is carried by a disease *vector (the Aedes aegypti mosquito*) with an incubation period of *1-7* days. This disease is often fatal and severe, where death occurs in *40%-50% of patients with shock.*
Epidemiological surveillance can be defined as a series of activities that are systematic and continuous in collecting, analyzing, interpreting data and conveying information in an effort to describe and monitor a disease/health event. In relation to communicable diseases, epidemiological surveillance activities aim to identify high-risk groups in the community, understand how the disease is transmitted and try to break the chain of transmission. In this case, each disease must be reported completely and accurately, which includes information about the person, place and time.
Puskesmas is a health service facility closest to the community whose function is to develop and foster public health and to provide health services in the form of comprehensive and integrated main activities in its working area. In carrying out its functions, the puskesmas makes plenary efforts which include promotion (promotive), prevention (preventive), treatment (curative) and recovery (rehabilitative).
The geographic information system is a very essential tool in storing, manipulating, analyzing and displaying natural conditions by combining spatial data (maps of areas including rivers, swamps, rice fields and others) and non-spatial/attributes (mortality, morbidity, habits / people's lifestyle and others). The results of the data processing are presented in the form of a digital map
The DHF early warning system is a system that can identify early occurrence of DHF disease, predict epidemic transmission and respond quickly to emergencies to prevent outbreaks/outbreaks
The rapid survey is a data collection method developed by *WHO (World Health Organization),* which has simpler requirements than conventional survey methods. This method applies a two-stage *cluster* sample design, with the selection *of clusters* in the first stage by *probability proportionate to size* and the selection of household samples in the second stage by *simple random*. Respondents were limited between 210-300 with 20-30 questions only.

Objectives: "How is the Development of a DHF Epidemiological Surveillance Information System Using a Geographic Information System that Can Be Used for Early Alertness in Pidie Jaya District?"

MATERIAL AND METHOD

The research to be carried out is an *operational research* because it includes system development to be able to solve the weaknesses of the current system. The system development approach uses the FAST *(Framework for the Application of System Techniques)* method according to the FAST stages. To compare the old system with the new system used qualitative methods, both in data collection and data analysis. This study uses observation techniques, in-depth interviews and *non-FGD discussions* to explore user needs as an

effort to obtain a system model that fits user needs.

The research design used is system modeling in selected health centers (case studies) that can be applied to other health centers. To find out the success of the new system, a *pre-experimental design* called *a one shot case study was used* , because the research was carried out on an experimental unit to be measured without using controls. The Puskesmas in Pidie Jaya was chosen as the research location because it has the most DHF cases in Pidie Jaya District and relatively complete DHF epidemiological surveillance data.

The research was conducted in two stages as follows:

1. Making a DHF Risk Factor Map
2. Making a "*Spot Map"* of DHF Cases

The explanation of each method and the tools used in each method are as follows:

1. Observation
2. In-depth interviews
3. Non-FGD Discussions

The data analysis is carried out in the following way:

1. Content analysis
2. Descriptive analysis

The stages of the research are based on FAST (Framework for the Application of System Techniques) as follows:

1. Preliminary Study (*Preliminary Investigation*)
2. Problem analysis (*Problem Analysis*)
3. Needs Analysis (*Requirement Analysis*)
4. Decision Analysis
5. Design (*Design*)
6. Building a new system (*construction*)
7. Implementation (*Implementation*)

RESULT

Pidie Jaya Regency is a fraction of Pidie Regency, with an area of 1,162.84 Km². Pidie Jaya Regency is located in the northern hemisphere of the Barisan Mountains which consists of mountainous areas, lowlands and water areas (sea). Pidie Jaya Regency was formed based on Law Number 7 of 2007, on January 2, 2007, which consists of 8 sub-districts, 34 mukim, and 222 gampongs.

1. The description of number health facilities in Pidie Jaya Distric

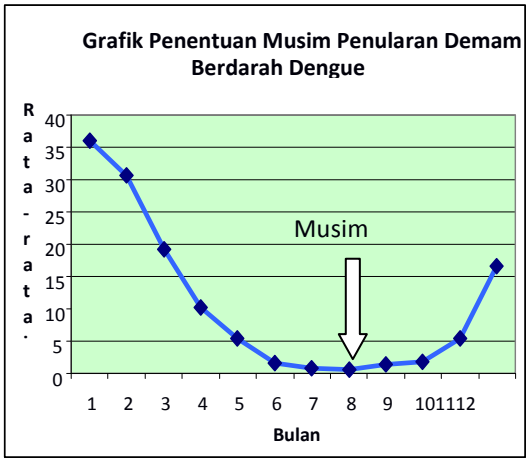
Number of Health Facilities in Pidie Jaya District

Kecamatan	Jumlah Sarana Kesehatan Dasar						
	Rumah Sakit	Puskesmas	Pusling	Pustu	Poskesdes	Posyandu	Praktik Dokter
Meureudu	1	1	-	4	16	30	4
Meurah Dua	-	1	-	-	17	19	2
Bandar Dua	-	3	-	3	12	48	5
Jangka Buya	-	1	-	1	10	18	2
Ulim	-	1	-	3	13	30	2
Trienggadeng	-	1	-	3	11	28	2
Panteraja	-	1	-	1	8	10	2
Bandar Baru	-	2	-	4	14	43	4
Jumlah	1	11	0	19	101	226	23

Sumber: Badan Pusat Statistik Kab. Pidie Jaya

Puskesmas based on the Decree of the Minister of Health of the Republic of Indonesia Number 128 of 2004 concerning Basic Policies of Puskesmas, is a technical implementation unit for the District Health Office which is responsible for carrying out health development in its working area.

2. Graph Of Contagion Season Determination



Season of transmission is useful for predicting the start time of the emergence of DHF cases so that control measures for early warning can be determined. The steps for determining the season of transmission have been described in Chapter II. The transmission season graph based on existing data at the Pidie Jaya Health Center is estimated to occur in August as shown in Figure 4.2. Besides being used to determine the right time to intervene, the transmission season can also be used as a basis for determining the time to update risk factor data as described above.

Based on DHF data at the health center in Pidie Jaya, it is known that in 2004 there were 285 cases, 6 of whom died. With a population of 81,119, *the IR* reaches 35.1 per 10,000 population, higher than *the IR* in Pidie Jaya district which reaches 11.5 per 10,000 population, and so the Pidie Jaya puskesmas is the puskesmas with the highest DHF cases in Pidie Jaya District. While the death rate / *CFR* is 2.1% which means it is higher than *the CFR* of Pidie Jaya Regency at 2.04%. Based on the indicators above, it can be said that the DHF eradication program at the Pidie Jaya health center has not been successful.

DESCRIPTION OF DHF RISK FACTORS THROUGH RAPID SURVEY ACTIVITIES

From the rapid survey activities that have been conducted on respondents in all villages in the area of the Pidie Jaya Health Center as planned in chapter III, the following results were obtained:

−Number of samples: 322
−Maximum risk factor score/value:11
−Minimum risk factor score/value: 1
− Average: 5.9286
− Standard deviation: 1.7687
− *Cut of point I*: 5
− *Cut of point II*: 5
− *Cut of point III*: 6
− *Cut of point IV*: 8
− *Cut of point V*: 11

TABLE 4.2 RISK FACTOR CATEGORIES OF DHF PUSKESMAS IN PIDIE JAYA

NO	VILLAGE NAME	AVERAGE	CATEGORY	FACTORMODE RISK
1	2	3	4	5
1	New Town	5.40	Currently	Afternoon Tdr
2	Pante King	5.60	Currently	Abate
3	Trenggadeng	5.63	Currently	Afternoon Tdr
4	Meureudu	5.63	Currently	Afternoon Tdr
5	Meurah Two	6.13	Tall	Afternoon Tdr
6	Buya Term	5.70	Currently	Afternoon Tdr
7	City Two	5.90	Currently	Afternoon Tdr
8	Ulim	6.09	Tall	Gtg clothes

Based on the categories according to *the cut of point* above and the average risk factors for each village, the categories of risk factors for DHF in the Pidie Jaya health center area are as follows:

DISCUSSION

Limitations of DHF Surveillance Information System

This DHF Epidemiological Surveillance Information System can provide daily, weekly, monthly and annual data on DHF cases in the form of information, reports, and maps in the area of the health center in Pidie Jaya, however the researchers realize that there are still limitations to the information system Epidemiological Surveillance Information System DBD with developed GIS,among others:

1. The existence of one village with two separate areas (Srobyong village) creates difficulties in analysis because the data *entry* comes from one village as a whole so that several analyzes such as endemicity stratification and risk factor levels do not appear. For this reason, in the next data *entry* , the Srobyong village data must be separated according to the data for each region.
2. Vector behavior factors that influence the incidence of DHF, such as mosquito flight distance and climatic influences such as rainfall and wind direction, as well as population mobility that allows the spread of cases from outside the area have not been covered in this GIS-based DHF epidemiological surveillance information system. The existence of natural phenomena such as *Elnino* as

well as variations in the arrival and length of the rainy season will also affect the *Aedes aegypti mosquito population*. For this reason, it can still be developed further by including spatial data and attributes regarding vector behavior, climate and other human behavior.

3. The implementation of the DHF risk factor rapid survey by Jumantik as input in this system, allows for data inaccuracies. This can be seen from the results of the rapid survey, which found it odd that the mode of risk factor in most areas is the habit of napping. Even though the environment of the health center in Pidie Jaya is an industrial area where during the day most of the population still works in furniture companies. This is understandable considering the educational background and lack of knowledge in how to collect data. For this reason, in the next rapid survey activity, Jumantik needs to be equipped with adequate knowledge about the procedure for collecting data, especially rapid surveys. It is also necessary to think about providing incentives outside of regular honorariums considering that this activity is an extension of their main duties which are only limited to periodic larva inspections. This incentive can be given by submitting a report on the results of their rapid survey to ensure data availability.
4. *merger* and *transfer* facilities, it cannot be used to analyze DHF data from other puskesmas. This is because there is no database of all puskesmas. For this reason, if this system is to be developed at the DHO level, it is necessary to take steps to develop the system with reference to this system.

CONCLUSION

Based on the results of the DHF Epidemiological Surveillance Information System research with GIS that was conducted and described in the discussion, the following conclusions can be drawn:

1. The DHF Epidemiology Surveillance Information System which has been running so far has many weaknesses, including: incomplete data, difficulty accessing data, difficulties in making decisions on DHF control, and less informative in presenting data.
2. The DHF Epidemiological Surveillance Information System that has been running so far has not been able to predict the possibility of a spike in cases in the context of early warning. This happens because predictions are only made based on endemicity stratification, larva-free numbers (ABJ) and five-year cycles, where the data used is not *up to date* . Especially for the five-year cycle, empirically it is difficult to accept, it is proven that there are frequent occurrence of DHF outbreaks every year.
3. In the preliminary study of the DHF Epidemiological Surveillance Information System, it was found that there are expectations, needs, opportunities, directions and policies that support the development of the Epidemiological Surveillance Information System.
   DHF using GIS. This can be seen from interviews with the head of the puskesmas, officers involved in the management of the DHF program as well as the vision and mission of the puskesmas. The development of the DHF Epidemiology Surveillance Information System using GIS is also supported by the DKK policy in the Puskesmas Management Information System (SIMPUS) program.
4. In designing the DHF Epidemiology Surveillance Information System with GIS, a data base was built, namely Province *files* , Regency *files* , District *files* , Village *files* , Community Health Center files, *patient files* , PE files, 3M movement *files* , *PJB files* , and *rapid survey files* . By building a database, in terms of data management, namely changing, adding, or deleting data can be done easily.
5. The DHF Epidemiological Surveillance Information System with the developed

GIS can display spatial data in the form of risk factor maps, risk factor mode maps, endemicity stratification maps, 3M movement maps, CHD activity maps, population density maps and DHF case maps. With this spatial data the presentation of the data becomes more informative and interesting and the analysis becomes easier.

6. The DHF Epidemiology Surveillance Information System with the developed GIS meets the information system assessment, namely simplicity. It is evident from the responses of all respondents who stated that the new system is easier both in data *input*, process and report generation.
7. The DHF Epidemiology Surveillance Information System with the developed GIS is able to overcome acceptability problems. It is evident from the responses of all respondents who stated that the new system has more complete data by including variables for surveillance monitoring (person, place, time) and the presence of DHF risk factor data as well as the recruitment of officers in each information system structure.
8. The DHF Epidemiology Surveillance Information System with the developed GIS is able to overcome accessibility problems. The system has been computerized so that data and information can be retrieved easily because all you have to do is open the DHF Epidemiology Surveillance Information System program with GIS and can find the data and information needed.
9. The DHF Epidemiology Surveillance Information System with the developed GIS is able to overcome data representativeness problems. This is evident from the responses of respondents who stated that the data and information generated by the new system can support DHF disease surveillance activities.
10. The DHF Epidemiology Surveillance Information System with the developed GIS is able to overcome the problem of timeliness of data processing. Evidenced by *user responses* stating that the new system is faster so there are no more delays in obtaining information to support dengue eradication.
11. The DHF Epidemiological Surveillance Information System with GIS that has been developed is feasible to be implemented as material for analysis, planning and evaluation of DHF prevention and eradication program activities. Evidenced by the assessment of system performance evaluation where all respondents stated that they almost strongly agreed (overall average = 4.72). While the old system respondents said they did not agree (overall average = 1.78).

Declaration by Authors
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