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Geospatial-Based Information Systems Model for Disaster Management of Reproductive Health

Model Sistem Informasi Berbasis Geospasial dalam Manajemen Siaga Bencana Sub Klaster Kesehatan Reproduksi

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ABSTRACT

Indonesia is a disaster-prone area, but it is often found that the response process is slow at the very beginning of a disaster. Furthermore, disasters are often unpredictable. Therefore, simulation of preparedness, mitigation, and disaster management should be conducted continuously and systematically, both in manual and electronic manner by utilizing advance technology in geospatial. The aim of this study to develop a model of geospatial-based information systems in disaster management of reproductive health sub-cluster (SIGAB KESPRO BISA) in Nusa Tenggara Barat. Data collection was conducted through in-depth interviews with several stakeholders. To complete the methodological approach and to obtain the system requirement, a content analysis was done toward in-depth interviews result. The research continued with the development of information system models. The analysis results by in-depth interview indicate the availability of infrastructure and the importance of the system offered. The SIGAB KESPRO BISA model needs to be composed of three main functions, namely preparedness and mitigation systems, logistics distribution, and reproductive health services. The design of the SIGAB KESPRO BISA model has been built to facilitate the process of developing the SIGAB KESPRO BISA application system so that disaster management can be carried out with high effectiveness and efficiency.
Kata Kunci : Reproductive health, disaster alert, geospatial

ABSTRAK

Indonesia merupakan kawasan rawan bencana, tetapi di lapangan sering ditemukan proses mitigasi yang sangat lamban pada saat paling awal terjadinya bencana. Bencana seringkali tidak dapat diprediksi. Oleh karena itu, simulasi bencana untuk melatih kesiapsiagaan, mitigasi dan manajemen bencana harus dilakukan terus menerus secara sistematis, dilakukan secara manual dan elektronik dengan memanfaatkan teknologi geospasial. Tujuan penelitian ini adalah untuk mengembangkan model Sistem Informasi Manajemen Siaga Bencana sub klaster Kesehatan Reproduksi Berbasis Geospasial (SIGAB KESPRO BISA) di Nusa Tenggara Barat. Pengumpulan data melalui wawancara mendalam telah dilakukan terhadap beberapa pemangku kepentingan, untuk melengkapi metode penelitian dan untuk mendapatkan kebutuhan standar sistem maka dilakukan analisis tematik terhadap hasil wawancara mendalam. Penelitian dilanjutkan dengan pengembangan model sistem informasi. Hasil analisis dari wawancara mendalam menunjukkan telah tersedianya infrastruktur dan pentingnya sistem yang ditawarkan. Model SIGAB KESPRO BISA perlu disusun atas tiga fungsi utama yaitu sistem kesiapsiagaan dan mitigasi, distribusi logistik, dan pelayanan kesehatan reproduksi. Model SIGAB KESPRO BISA telah dibangun untuk mempermudah proses pengembangan aplikasi SIGAB KESPRO BISA sehingga diharapkan manajemen bencana dapat dijalankan dengan efektifitas dan efesiensi yang tinggi.
Keywords : Kesehatan reproduksi, siaga bencana, geospasial

INTRODUCTION

Indonesia is a disaster-prone area, but in the field, it is often found that the response process is slow at the very beginning of a disaster. Furthermore, disasters are often unpredictable. Therefore, preparedness and mitigation should be conducted continuously and systematically, both manually and electronically by utilizing geospatial technology.[1,2] When preparedness and mitigation can be done well, then the risk of casualties and the post-disaster impact can be minimized. This study will try to make electronic preparedness and mitigation solutions to cope with the problem.[3,1]

According to the world risk report (2016), most of Indonesia's territory falls into the category of regions that have a high-risk index for disasters in the world, where Indonesia ranks 36th for the highest risk of disaster occurrence, this position has increased 2 times higher than the previous 2 years.[4] The same thing was also conveyed by the Head of the Crisis Center of the Ministry of Health in the coordination meeting of reproductive health sub-cluster in October 2018 that Indonesia was a natural laboratory of disasters, this happened because Indonesia was located between three major plates of the world, namely the Euroasia plate, the Indo-Australia plate, and the Pacific plate, moreover that Indonesia is also included in the Pacific Ring of Fire.[5,6]

The vulnerability of Indonesia's territory to natural disasters needs to be a serious concern of the government to minimize the number of victims. The occurrence of natural disasters in the last few years should be our reflection because every time a disaster takes a significant number of victims, both victims during and after the disaster. For example in the earthquake disaster in Lombok in 2018, the number of victims died reached 436 people,[7] while the victims in Palu and Donggala were greater, reaching 2096 people, and several other disasters also claimed quite a lot of casualties.[8] A large number of victims illustrates the lack of preparedness of the government and citizens in dealing with natural disasters.[9,10]

To reduce and prevent victims of disasters, preparedness and mitigation efforts must continue to be carried out in innovative and sustainable ways. Preparedness is a series of activities carried out to anticipate disasters, while mitigation is an effort to reduce disaster risk.[11] There has been a lot of preparedness and mitigation efforts undertaken by the Indonesian government, but the efforts made do not seem to have the expected results. However these efforts must continue to be carried out continuously with various and the latest innovations in technology, as we know today the development of information technology systems especially in geo-spatial information system is growing very well and quickly, and that will be very helpful in increasing disaster preparedness and mitigation, and disaster management itself such what have done in some countries like Turkey, and Haiti.[12,13,3]

Based on the experience of the Lombok earthquake and its management process, the role of geospatial was likely to be very helpful in the process of disaster management. At beginning of a disaster, the community panicked did not know what was happening and what had to be done, especially when tsunami risks information delivered by BMKG. This condition was exacerbated by the lack of directions and safe evacuation sites that could be addressed. In this case, the geospatial system could be a solution for giving directions to the community to get the nearest secure location. In the next stage, the reproductive health disaster management team from various backgrounds that was located in the health office of NTB province had no idea about the refuge points location and the distribution of vulnerable victims namely pregnant women, children, and teenagers in each refuge point. Due to the lack of this information, the decision-making process to evacuate the vulnerable victims was hampered. Because of this condition, the mapping process was done manually, and the result would be available in 2-3 weeks after the disaster. In this second case, the geospatial system will provide automatic mapping results since the start of the first case.

Seeing the good potential of the geospatial information system in helping disaster preparedness and mitigation, and disaster management above, this research will try to design a model of disaster alert information system in which the disaster alert system will be integrated directly with the early warning system that operated by BMKG and the geospatial system that owned by BPBD. This model will focus more on the management of reproductive health sub-clusters, where this sub-cluster is one of the disaster management sub-clusters in a health cluster that already has a standardized manual system issued by the Ministry of Health in the form of a minimum initial health service/P*aket Pelayanan Awal Minimum* (PPAM) which consists of 7 management components.[6,14,15]

MATERIAL AND METHOD

The system development method that was used in this study was the prototype, where the system developed through a series of repetitions to include the changes needed until the system meets the desired criteria,[16] but in this study only reached the modeling stage. The primary data collection had been conducted to find out the minimum system requirements. Primary data collection was done by in-depth interviews using interviews guideline at several agencies involved in the disaster management process in NTB such as BPBD, health department province NTB, and Ministry of Health of Indonesia. The in-depth interviews that had been conducted were about preparedness and mitigation, and the implementation of disaster management, especially in the reproductive health sub-cluster. To find out the details of the minimum standard requirements and to complete the research methodology approach, a content analysis was carried out on the results of in-depth interviews. To triangulate the finding, a document review of disaster management also conducted. After determining the minimum standard requirements, the study had been continued with the model design of geospatial-based information systems in disaster management of reproductive health sub-cluster named SIGAB KESPRO BISA.

This research was conducted in Lombok, NTB, it was done from September to October 2019 with 7 informants consists of 4 informants from health department province NTB (3 informants from family health division, and 1 informant from surveillance and disaster health division), 1 informant from BPBD province NTB, 1 informant from Ministry of Health of Indonesia, and 1 informant from Gelogor Village one of villages in province NTB.

RESULT

The process implementation of preparedness and mitigation in province NTB has already run and reached the village level. Moreover, at the village level, a disaster program called the disaster-resilient village/Desa Tangguh Bencana (DESTANA) was created. This was based on information from an informant in BPBD province NTB. In order to validate the information, the researcher did the validation to the village level. It was in Gelogor village, Kediri sub-district, West Lombok, the informant stated:

> "*At present not many villages have become disaster-resilient villages, for example in Kediri sub-district only Gelogor Village has implemented a disaster-resilient village programs, and Gelogor's village status as a disaster-resistant village will be determined soon by the BPBD.*" (Informan-7)

Based on what was stated by the informants above, it reflects the uneven efforts of NTB province government in implementing disaster preparedness and mitigation. Based on data obtained from the BPBD province NTB website, the number of DESTANA until 2019 is 39 villages out of 1.143 villages in province NTB.[17] This is a great homework for the NTB provincial government to equalize preparedness and mitigation efforts throughout province NTB. The lack of preparedness and mitigation efforts in non-DESTANA areas was also illustrated when the Lombok earthquake occurred. The community panicked and did not know what to do and where the safe points could be headed, especially the community in Gunungsari sub-district, West Lombok District.

From the brief description above and the results of in-depth interviews of 7 informants, can be extracted some of the SIGAB KESPRO BISA design system requirements as described below: Firstly, the availability of data and early warning information systems in the province of NTB. BPBD (Regional Disaster Management Agency/Badan Penanggulangan Bencana Daerah) already has data on disaster-prone areas and its ordinate points as well as evacuation routes that can be traversed by the community, as stated by an informant from BPBD:

> "*We already have evacuation points and routes. We got these data from RENKON (contingency plan/rencana kontingensi) activity that had been done in every district*" (Informan-5)

The data will be a database resource for the SIGAB KESPRO BISA model. While the early warning information systems that have been applied widely in Indonesia, including in NTB, it will be a supporting system for this model.

Secondly, the spanning of internet networks has reached almost all areas, including remote areas of the province NTB and the only 207 villages out of 1143 villages that categorized as blank spot areas.[18] Moreover, there is a commitment from Telkom to optimize network connectivity when a disaster occurs. Based on the result of a stakeholder meeting with Governor of NTB in 2018, Telkom has committed to immediately repairing the connectivity if there is network disruption during a disaster, the repairing process will take no more than 1 day. This will optimize the workflow process of the SIGAB KESPRO BISA system.

The third system requirement is the reproductive health sub-cluster has obvious guidelines for health services in health crises in the form of a minimum initial service package (PPAM) issued by the ministry of health with clear standards. In the implementing of the SIGAB KESPRO BISA process, it will be using an existing system that has been built before and has complete structure from top-level (health ministry) to the lowest level of the health service provider (village midwife).

The next system requirement is the Head of Health Office Province NTB has a plan to create a separate disaster agency or a disaster technical implementation unit in 2020 which will focus more on the effort of disaster preparedness and mitigation. Further, this will strengthen the disaster management in province NTB. This was like the informant statement from the division of surveillance and disaster health in the health office of NTB province:

> "*Hopefully soon we will have an information center in the form of a disaster technical implementation unit. This unit will be responsible to respond to every disaster condition, the Head of Health Department hopes that next year it can be realized*" (Informan-4)

The last system requirement found, in NTB Province or even in national level no disaster information system provides information on hazards situation while directing the community to a safe place after information delivery, and the unavailability of information systems that can record and report primary data of disaster victims these information base on informants from Health Department of NTB Province and Health Ministry of Indonesia bellow, as stated below:

> "*During the disaster response? the lack of available data and information. At that time the existing system was not running due to the disaster, and the data was retrieved manually through a long process. Finally, we use the last data of vulnerable group that we have*" (informan-1)

> "*Our application system currently only records aggregate data of victims, while the system that records primary data doesn't exist yet*" (informan-6)

This unavailability results in difficulties to conduct monitoring and evaluation quickly and on target. Which led to the slow decision making especially related to the 7 components or activities of reproductive health, like what was stated by the informant:

> "*We did not see that much detail, at that time PLHAs were served, and INSET was in control of this case and we only received reports from them, basically more than 500 PLHAs had received access to ARVs, etc*." (informan-1)

Moreover, the people involved when handling disasters in reproductive health sub-cluster team consists of various elements of the community, both group and individual, health workers or non-health workers participate in helping the process of disaster management, this situation will increase the difficulty of the process of coordination in the field.

Base on the results of the research above, bellow will be presented design models of SIGAB KESPRO BISA, and its steps: In the first step was designing the Context Diagram (CD). The CD in this system divided into two entities, namely source and target entities, which become source entities include BMKG early warning systems, BPBD, community, admin, and health workers. And the target entities include stakeholders, the head of the reproductive health sub-cluster coordinator, and the community (Figure 1). In the SIGAB KESPRO BISA model, the community is the focus of the system activities. In this case, the community indirectly provide their location to the system through the installation of apps and activation of their smartphone's GPS. The existence of these locations will be very useful for the distribution of logistic package and health worker.

Figure 1. Context Diagram of SIGAB KESPRO BISA

The next step was designing Entity Relational Diagram (ERD). ERD of SIGAB KESPRO BISA model explains the relationship between each system, where the first system is an early warning system of hazards, this system is as a trigger for system activation (Figure 2). The early warning system is obtained from the integration of SIGAB KESPRO BISA with the BMKG's early warning system. After activation, the community will be directed systematically to the safe point that they can reach and at the same time it will become a refugee shelter post if needed, from this process, the second and third systems will be executed. The second system is the logistics package distribution process, these distributions are done based on the community's locations that have been pointed in the first system, as well as the third system that is health worker services will be directed based on those locations.

The last step was designing Standard Operating Procedure (SOP). In this section, SOP divided into three parts of systems that are disaster alerts, logistical packages distributions, and health services (Figure 3, 4 and 5). Those systems have been mentioned in ERD and will be explained in more detail in this step.

The first, SOP of disaster alert system is an initial process that will activate SIGAB KESPRO BISA, starting with an early warning of hazards. After that, the system will automatically direct the community to the safe point base on the geographic information system that integrated with the SIGAB KESPRO BISA system. This event will break down people's accumulation in one place to some different places. Then, followed up by the local health officers to validate the number of vulnerable targets that are at these points. SOP of disaster alert system clearly illustrated in figure 3.

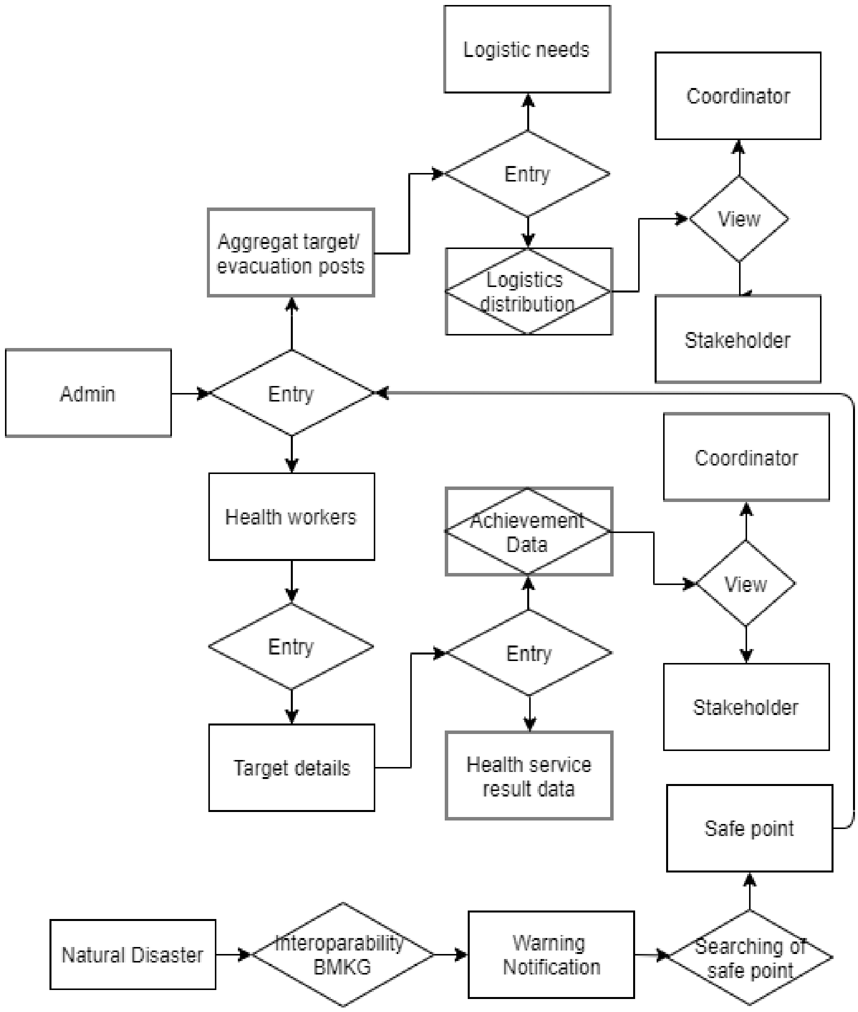

Figure 2. Entity Relational Diagram (ERD)

The second, The SOP of logistical distribution system is a follow-up process of the SOP of disaster alert system, where the refugee shelter posts and the numbers of the vulnerable targets identified as valid data, then, the logistics packages distribute to these refugee shelters. The distribution process will be monitored by the coordinator continuously. When the distribution seems unequally distributed, the coordinator will confirm to the administrators that they should pay attention to the existing logistic stocks and vulnerable targets that haven't received the packages. On the other hand, if it is well distributed the coordinator will report to the stakeholders toward the achievement of logistics distribution. Those steps can be seen clearly in figure 4.

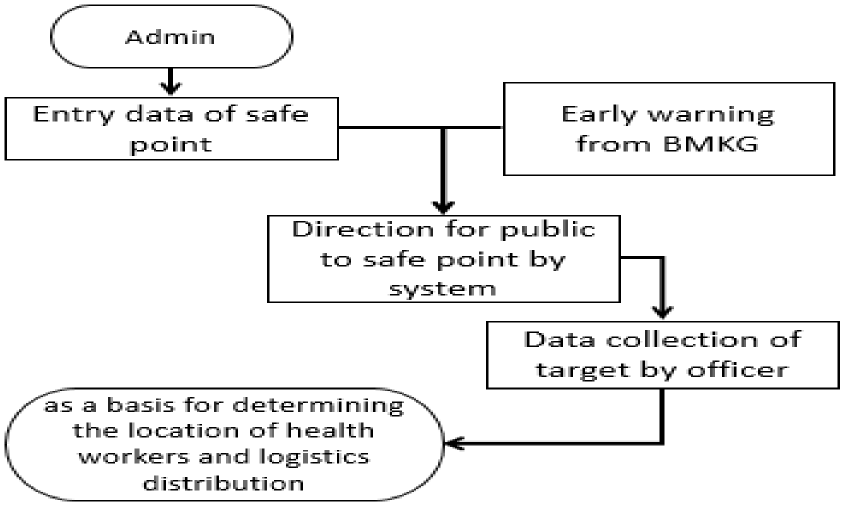

Figure 3. SOP of Disaster Alert

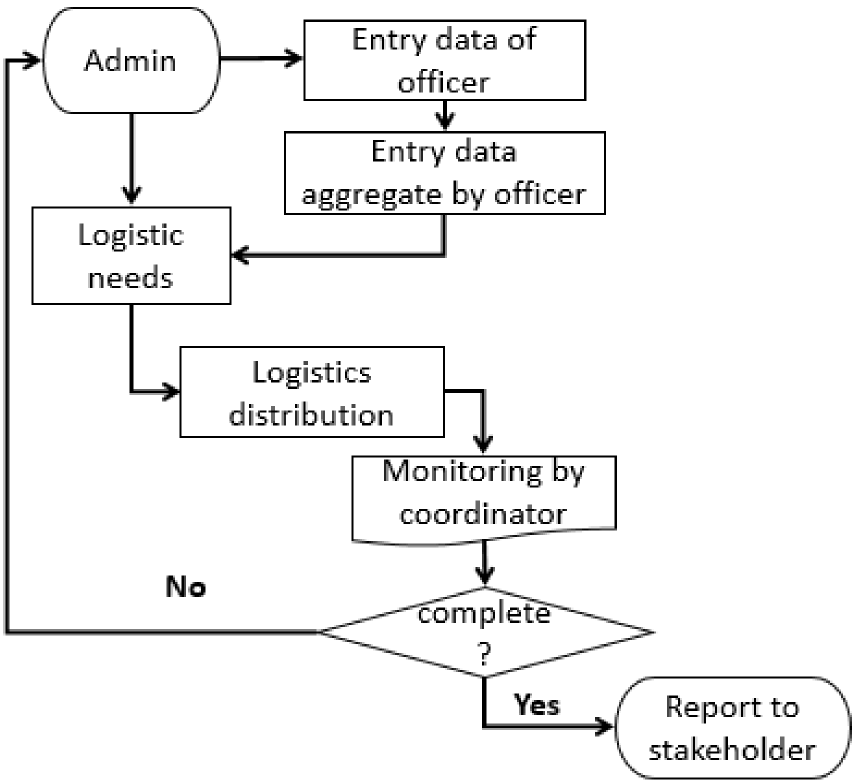

Figure 4. SOP of Logistics Distribution

The third, SOP health services system is like SOP logistical distribution system, where this SOP executes after the location of vulnerable targets and evacuation post identified. The administrator determines the placement of health workers base on these locations. The distribution process of health workers is also monitored by the coordinator continuously.

When there is an unequal distribution of health workers and health service achievements, the coordinator will confirm to administrator to add health workers where health workers are still lacking, or health service performance outcomes are low. The illustration of SOP health service system can be seen in figure 5.

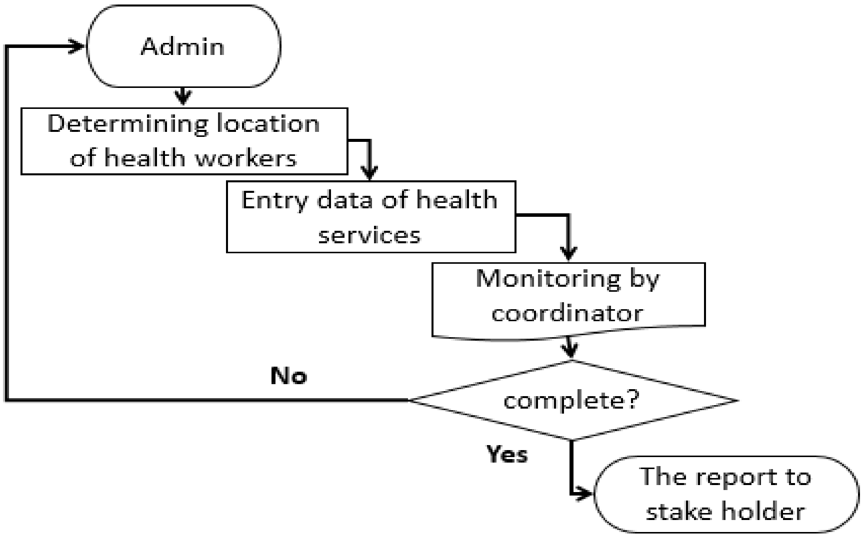

Figure 5. SOP of Health Services

DISCUSSION

The SIGAB KESPRO BISA model was designed in two technology bases, web-based and mobile-based to answer the needs outlined previously, which are integrated with geospatial real-time data. The design of this model is an integral part of the disaster management program, which focuses on the pre-disaster phase or preparedness and mitigation, and the emergency response phase, this model is expected to support disaster management in these phases.

The utilization of geospatial points has been widely studied to improve disaster management performance in all phases, such as the pre-disaster phase, the emergency response phase, and the post-disaster phase. Some researches that had been done like determining locations that were affected by disasters by utilizing geospatial technology and artificial intelligence,[19] determining safe evacuation points for disaster victims,[20] and many other uses of geospatial technology that have been investigated in improving the effectiveness of disaster management.[1,2,12,21,22,23]

Based on the needs of the two phases and the role of geospatial technology to improve the effectiveness of disaster management, the SIGAB KESPRO BISA model has been built, in which community preparedness and mitigation will be directed to the nearest safe gathering point-based geospatial point, and then followed by a management mechanism for logistics distribution and health services to the place where they gather. The model has utilized geospatial real-time technology.[2]

This model is a refinement of the results of previous studies, where the first study focused on disseminating information on early warning of danger and guidance to the public so that they can use the evacuation routes provided, where all processes are carried out manually through social media.[24] Another research result has used an android application that can display evacuation route maps, but only displays a map that is static without any direction from dynamic application where there is interaction between officers and the public.[25] The model in this study is built on a pre-existing system, where the application is planned to be a more effective disaster management tool, and as an intensive communication tool between officers and the public.

The SIGAB KESPRO BISA model has some features that can be explained through the entities in it, to be more clear about these entities can be seen in Figure 1 about the context diagram, in general, there are two entities namely the source and target entities, but In this discussion, we will explain more about source entities which consist of four entities, namely BMKG, community, admin, and health workers. The first feature is the integration of disaster early warning and geospatial systems, where the entities involved in this feature are BMKG and community entities. BMKG provides input for early warning of danger, such as tsunami, or other hazard warning, then followed up by providing a map of evacuation routes for the community, while the community provides input of their location, which can be seen directly by the administrator through the application map on the admin side.[2]

The next feature is a geospatial-based disaster management system, this feature is a continuation of the first feature, wherefrom the first feature, we can be known the location of the affected community shelter posts and the number of targets that are in the evacuation posts so that the distribution of logistics and health workers can be done systematically and effectively according to the needs. Such a system has been made and tested in China, the results obtained that the information system created significantly improves the system of disaster management performance in China.[21] Similar research was also carried out in Turkey and considered successful in improving the quality of disaster management implementation in that country.[3]

CONCLUSIONS AND RECOMMENDATION

The design of the SIGAB KESPRO BISA model was built to facilitate the process of developing the application system so that disaster management can be carried out with high effectiveness and efficiency both in "the preparedness and mitigation phases" and '"the emergency response phase". The phases in this model are integrated with geospatial information systems. It is hoped that the SIGAB KESPRO BISA model can be immediately developed in the form of applications so that the benefits can be immediately felt by the community in reducing the impact of disasters. To support the geospatial application function that will be developed, it will be necessary to develop a computer network system model that has a wide range coverage and low energy consumption as well as appropriate to the contour of the region of NTB province in particular and Indonesia in general.

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