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Application of Information and Communication Technology for Community-Based Landslide Risk Management

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Abstract. The research location is in the village of Wukirsari, Imogiri, Bantul Regency, Special Region of Yogyakarta. The study was conducted quantitatively and qualitatively, with data collection by purposive and snowball. Landslide area of 7,922 m2 on 17/3/2019 was at coordinates 433409.04 mE, 9124439.00 mS, moving towards N190oE. The type of landslide is found in the form of rock flow and debris slide. Landslides are triggered by high rainfall and nonworking drainage system in the study area so that the water load increases beyond the critical limit. Until now there has been no landslide information system. The model of applying information and communication technology via digital audio and visualization media has been able to increase community-based awareness of resilience in (1) assessing landslide risk, (2) monitoring character of landslide hazards, (3) disseminating information on potential landslides, and (4) strengthening community response capacity against landslides.

Keywords: information and communication technology for landslide risk management

INTRODUCTION

Around the world, natural disasters are unavoidable, but humans can minimize the losses caused by them. Landslides are one of them that often occur in the Special Region of Yogyakarta. BNPB recorded approximately 2426 incidents from 2014 to 2019 which caused some losses. There is one incident that recently happened, it was a landslide that occurred at the tomb of the kings which was in the Imogiri area with coordinates 433409.04 mE, 9124439.00 mS. Precisely this occurred on the south side and resulted in 7,922 m² landslide area. The landslide, which was triggered by high-intensity rain, had at least breached the walls of the tomb complex, and buried 2 houses. Until now, Imogiri District is still one of the areas in Bantul Regency which is often affected by landslides.

FIGURE 1. Research location

Community Based Disaster Risk Management (CBDRM) is one of the important pillars in today's disaster risk management jobs. So far, CBDRM has only been generally accepted by disaster experts because the approach used is a structural / physical approach only and focuses on emergencies as well as a top-down approach that rarely produces results in the realm of sustainable disaster risk reduction (DRR). CBDRM gives answers that cover several principles such as efficiency because ideally it has low transaction costs due to maximum local intake and minimum external intake [1].

According to Kuppuswamy and Rajarathnam[2], Information and Communication Technology (ICT) has great potential in disaster management. Collecting data and information related to past disaster events is particularly useful so that it can become a knowledge base in making technology for early detection of disasters. Disaster management includes preparedness, emergency response, and recovery. The use of ICT in disaster activities is very necessary, both during preparedness, emergency response, and recovery. For example, the use of handy talkies as a means of communication and coordination between volunteers and field command central, email as a means of communication to send reports in the form of text and audio-visual messages through the internet, social media, use of early detection tools, and remote sensing using satellites or drones.

Of course, to continue to develop the existing potential, it is necessary to map the ICT that has been used. That way, in the future, ICT products can be developed based on the evaluation results of the mapping. Therefore, the purpose of this study is to describe and evaluate the use of ICT in community-based landslide disaster risk management in Imogiri District, Bantul Regency.

ICT Solutions based on module by United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT/ESCAP) entitled ICT for Disaster Risk Management, 2011[3] are as follows. ICTs are providing an increasing number of solutions across all government and commercial sectors including DRM. An ICT solution generally comprises technology, software, and data standards.

Technologies

There is an enormous wide range of innovations accessible that can enhance DRM interventions, and regularly solutions will consolidate different technologies. The technologies should be consistently suitable for the client, regardless of whether this implies just utilizing pen and paper.

Databases

Databases are utilized to store, analyze, and retrieve information in electronic structure; they will normally be a part of any ICT solution.

Web Applications

One of the popular technologies used for providing user interfaces with ICT solutions is web applications. They can be accessed through an internet browser, so there is no need any additional software that must be installed on user's personal computer. They can be configured on the public Internet, on a closed intranet, and even on a single personal computer.

Geographic Information System (GIS)

A computer system for storing, managing, and displaying geographical information. GIS will be essential for most ICT solutions for DRM since a significant part of the data identified with DRM has a geographic segment to it.

Sensors

A device used to monitor events in its coverage area, as input data for a hazard detection system. For examples, seismographs, weather satellites, river water gauges, and ocean buoys. It should be noted that sensors are an important part of complete ICT solutions.

Radio Broadcasts

Considered as "old" ICTs, but they remain unforgotten, even as new technologies emerge. Radio is easily accessible and relatively cheap f[2] many people. It can be an effective way to share public information. In Asia and the Pacific, radio broadcasting has been used to disseminate early warning messages, and also for community education.

Mobile Phones

Mobile phones have various uses for ICT answers for DRM past their usefulness for voice communication. Cell broadcasting can be utilized to show messages on all mobile phones inside a geological territory. Text messages can be utilized to gather data from public, it is often more robust than voice correspondence in the result of a disaster when the media communications framework might be damaged or overload. Currently, almost all mobile phones can connect to the internet. They have also become smarter, have increasingly similar functionality to computers, and are equipped with cameras and Global Positioning System (GPS), enabling them to become data collection devices.

Social Media

Social media is technology that enables people to easily create and share information within their social networks and publicly on the Internet. Social media challenges conventional data streams in DRM activities. Currently, information about victims affected by a disaster is possible to be provided by the victims themselves, whereas previously this information may only be provided by professionals or the authorities. Of course, this information still must be further processed and verified. Stakeholders must be able to respond to this phenomenon to be able to make it an ICT solution. Besides being used in the emergency response period, they are also useful in other DRM cycles. They can be used for early warning, recovery coordination, fundraising, educate, and campaign. They also provide alternatives in providing psycho-social support for survivors.

Software

Nearly all ICT solutions consist of software components. There are many ways to provide suitable software:

Commercial off-the-Shelf Software

Commercial off-the-shelf software offers a proven (or possible customizable) solution to its advantage. This software developer sells or licenses this software to other parties, either in the form of a single payment or periodic license payments, and of course with the agreement on technical support that will be provided.

Custom Built

Sometimes it will be more effective to develop custom software as an ICT solution for certain cases, but the thing to note is that the developer must be able to provide technical support in overcoming problems that may arise when using it, as well as in developing software according to future developments or changing needs. The client should consider this as a budget matter. This is because if the original developer is no longer working with the

client, sometimes it will be difficult for new developers to develop or make changes to the software. For example, sometimes new developers will have problems with ownership of the product from the original developer.

Free and Open Source Software

Free and Open Source Software can be used without restriction, users can freely copy, study, modify, and redistributed the software. Most of this is supported by collaboration from various circles of society to develop software that is useful for all parties, they can come from academics, volunteers, community organizations, or companies.

Data Standards

As ICT solutions become more prevalent and more people or organizations are involved, problems will arise if the information is shared in different formats or maybe even incompatible with one another. Data standards will help integrate ICT solutions by ensuring that the data shared is recognizable by different software packages without the need for manual conversion. The most appropriate are standards that are open and non-discriminatory. Any system can implement it, and all interested parties can participate in its development.

Lifecycle

The lifecycle of an ICT solution needs to be considered in determining different DRM interventions. here is the lifecycle of an ICT solution.

Stage 1: Requirements and Specifications

Identify the problem to be solved and collect requirements for the solution is the first stage of developing any ICT solution is. These will help to identify the required technologies and specification that will be implemented.

Stage 2: Implementation and Training

It would be good if the solution's component was installed then do ICT training. For example, practice reading sensors and recording data for field officers.

To ensure that learning is not lost, training on its use may need to be repeated periodically because ICT solutions for disaster response may not be used often. Simulation is an effective training method. If the public is involved in it, it is important to tell them how the system works and what actions to take on the information received.

Stage 3: Maintenance

The infrastructure of any ICT solution needs to be maintained to ensure reliable performance. All hardware has a limited lifespan, the likelihood of failure becomes even greater once this limit has been passed. Likewise, in software, errors or bugs are often found during initial implementation, or when developing additional features. It is important to consider how this will be implemented.

It is necessary to ensure that there are backups of all DRM information in multiple locations. So that if any data is lost, the system can be recovered efficiently. Case in point, in Haiti, a large amount of government information was lost when its office collapsed in an earthquake in 2010.

METHODOLOGY

The research used a field study approach, with qualitative research methods. The data analyzed were sourced from the internet and interviews in the field.

The sampling of data sources in the interview was done by purposive and snowballs. Purposive is a data collection technique with certain considerations, for example the respondent is considered to know what we expect or as a decision maker to make it easier for research needs. Snowball is a sampling technique for data sources that initially had few respondents but were unable to provide complete data, so they had to find other respondents who could be used as sources of data information.

The location of this research is in Wukirsari Village and its surroundings, Imogiri District, Bantul Regency, Yogyakarta Special Region Province. Wukirsari Village is located about 16 km on the south side of Yogyakarta city. This village is one of 8 villages in Imogiri District. The total area is 15,385,504 ha with a population of ± 17,245, consisting of 5,428 families. This village is bordered by Segoroyoso Village and Trimulyo Village on the north side, Muntuk Village on the east side, Girirejo Village on the south side and Trimulyo Village on the west side.

From the analysis carried out, the findings of this study will be known. The results of this study are mapping the use of ICT in community-based landslide risk management activities in Imogiri District, Bantul Regency in an effort to strengthen community preparedness through (1) assessing landslide risk, (2) monitoring the character of landslide hazards, (3) disseminating landslide potential information, and (4) strengthening response capacity.

RESULT & DISCUSSION

Based on the field data obtained, there is no early warning system for landslide hazards in this area. Respondent named Afan who is one of the village officials in Wukirsari Village confirmed this, but Afan said the Disaster Risk Reduction Forum in Wukirsari Village has increased the understanding and capacity of residents in responding to disasters that occur through outreach activities. Socialization activities were carried out using digital visualization in the form of videos and presentation slides. UN-APCICT (2011)[3] also write about ICT for Risk Knowledge, Innovation and Education. They say that information by itself is not knowledge. Being aware of the hazards does not automatically lead to reduced risk. So, to increase their capacity to find appropriate risk reduction solutions and techniques it is especially important to train and promote sustainable learning in vulnerable communities. Among decision-makers, it is also important to promote risk education as "development" decisions can influence risk. Many decisions that affect vulnerable communities are driven by external decision-makers, including national and local governments and private companies. E-learning, distance education, open learning or online learning tools that utilize Internet and multimedia technologies (combining video, sound, animation, text and graphics) have great potential for education about DRM. One example is the World Bank Institute's distance learning program on DRM, which includes courses on mitigation topics such as "Community Based Disaster Risk Management", "Safe Cities", and "Risk Sensitive Land Use Planning". Television media and newspapers can greatly contribute to increasing public awareness. As there is increasing awareness of the need to include media representatives and journalists in mitigation programs, they are also being targeted as training groups to encourage reporting on DRR before disasters occur, although most media coverage is still focused on major catastrophic events and more often displays dramatic impacts that occur. happened because of the disaster. The challenge is how to keep the public's attention, and to keep key stakeholders actively interested and involved in these efforts, when conditions are conducive, that is the time for DRM capacity to be strengthened to avoid future losses.

Meanwhile, a respondent named Suwono, who is one of the residents around the landslide area, said that residents use the WhatsApp group to communicate and coordinate when there is a danger or a disaster occurs.

Although these efforts have more or less increased the capacity of the community in responding to disasters that have occurred, the absence of an early warning system in the landslide area has resulted in casualties. Azhari, a royal servant at the tomb complex of the kings in Imogiri, said that the landslide occurred at night, so that none of the residents realized when it was about to occur.

Other efforts were also made by various parties to increase community resilience. One of them is from the academics, in the research entitled COMMUNITY-BASED LANDSLIDE PREVENTION AND MITIGATION IN WUKIRSARI VILLAGE AND ITS SURROUNDINGS, IMOGIRI KECAMATAN BANTUL, YOGYAKARTA SPECIAL REGION by Eko Teguh Paripurno with his team in 2020, they carried out a series of activities that use ICT to achieve the expected achievement targets, namely (1) The occurrence of a community / partner prevention and mitigation process, (2) The strengthening of the preparedness of the community / partners; (3) The community / partners will disseminate their capabilities to other areas. The activities and ICT media used are shown in the following table.

TABLE 1. Information and Communication Technology media usage

Activities	Information and Communication Technology media
Disaster risk assessment	GPS, ArcGIS, digital earth map
Hazard character monitoring	PowerPoint slide presentations
Disseminating landslide potential information	Video, PowerPoint slide presentations
Strengthening response capacity	Video, PowerPoint slide presentations

In disaster risk assessment, GPS, ArcGIS, and digital earth map are used to create landslide hazard maps in the research area. GIS is one of the best comprehensive platforms for processing multi-layered geo-referenced information, including hazard mapping, mapping of incidents, population and natural resources and critical critical infrastructure, and damage and loss estimates. The GIS based database makes the decision-making process easier and more effective than traditional systems. Detailed databases are among the most important roles of GIS and play an important role in the planning and implementation of large-scale preparedness and mitigation initiatives.

Next, in the hazard character monitoring activity, a group discussion forum was conducted using PowerPoint slide presentations as a medium of communication with participants. For Disseminating landslide potential information and strengthening response capacity activities, digital visualization media in the form of videos and PowerPoint slide presentations are used, so that it is hoped that participants will more easily understand the information presented and be able to spread their knowledge to the wider community. The four activities are in accordance with the four principles of an effective early warning system, so it is hoped that it will encourage the establishment of an early warning system for the people in the research area. Because, although these efforts have more or less increased the capacity of the community in responding to disasters that have occurred, the absence of an early warning system in the landslide area has resulted in casualties. Azhari, a royal servant at the tomb complex of the kings in Imogiri, said that the landslide occurred at night, so that none of the residents realized when it was about to occur.

In fact, the regional disaster management agency of the Special Region of Yogyakarta already has an early warning system for landslides based on the latest technology. In this system there is a sensor that is connected to a smartphone, the sensor will send a condition report in the field to the smartphone of the person operating it, either us or the village apparatus. The sensor as an early detection tool for landslides will always send a signal to the smartphone, if the sensor stops sending a signal, it indicates a problem with the sensor in the field.

FIGURE 2. Landslide monitoring application on smartphone

However, this early detection tool for landslides has only been installed in several landslide prone points in the Special Region of Yogyakarta, in the village of Wukirsari itself, which is where this research was conducted, it has not been installed.

CONCLUSION

The model of applying ICT via digital audio and visualization media has been able to increase community based awareness of resilience in (1) assessing landslide risk, (2) monitoring character of landslide hazards, (3) disseminating information on potential landslides, and (4) strengthening community response capacity. However, an early warning system still needs to be applied immediately to further increase community resilience.

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