Disaster Mitigation and Emergency Help with Public Address(PA) System Design Based on Audio Over Ethernet (AoE), IDS, and IOT in Hospital

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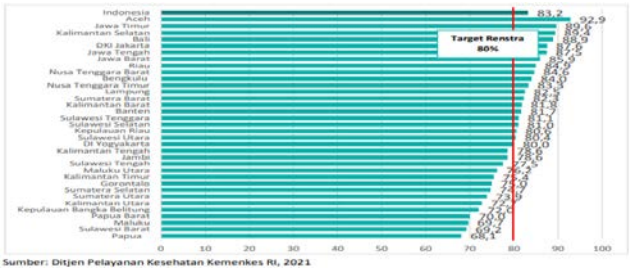
***Abstract*— This research aims to build an internet-based communication channel for disaster mitigation as well as monitoring patients during a flood disaster in a hospital environment using Audio Over Ethernet (AoE), Information Display Systems (IDS), and Internet of Things (IoT). Communication between buildings external to the hospital to provide information to patients and medical personnel who are spread out will use a Public Address System connected to an Amplifier (AoE) which can be implemented in written form using DIS. Furthermore, this device can communicate with other IP-based PA system devices such as PA System Network Controllers as servers, remote microphones or other devices over the network using IP Addresses. Which is divided into subnets for each different building, IP routes are implemented on Cisco layer 3 switches. Furthermore, IoT devices contained in patient room units will provide information in the form of conditions as well as information about safety and comfort during medical treatment. The development of an AoE, IDS and IoT based system will then be packaged in the form of an application to make it easier for medical personnel to monitor the patient's condition while providing information to the patient's family.**

***Keywords*— Emergency help, switch, Audio over Ethernet, IDS, IOT**

I. INTRODUCTION

Based on the Health Profile, Indonesia in 2020 had 2,985 hospitals consisting of 2,449 general hospitals and 536 special hospitals [1] spread across all provinces and regions. cities and districts (Figure 1). Human resources in hospitals consist of medical personnel, pharmaceutical personnel, nursing personnel, other health personnel and non-health personnel [3],[4]. Indonesia has areas prone to disasters such as floods, landslides, earthquakes, etc. In 2021, there were 1,938 flood disasters recorded in various different regions in Indonesia. Meanwhile, there were 64 earthquakes in the same year [2]. Meanwhile, 3,350 natural disasters were recorded from 12 December 2021 to 12 December 2022 with a total of 250 fatalities, 8,703 injured, 43 missing and 5,143,027 missing [5]. Earthquake and flood disasters that come suddenly require immediate treatment. Evacuation and assistance



Figur. 1. Hospitals in Indonesia

to disaster victims is a top priority that must be carried out immediately. Meanwhile, hospitals as medical care centers for local communities are also affected by disasters and it is difficult to carry out health care processes because information is not received due to broken communication. Furthermore, patients who are being treated also need supervision by medical personnel and health workers at the hospital [6]. Based on these problems, serious treatment is needed so that hospitals as medical care centers can continue to operate according to their capacity.

There is identification of problems in the form of medical treatment of disaster victims from outside (external to the hospital) and from within the hospital. The main need for external mitigation is accurate information about disaster conditions in the affected environment and the availability of nearby hospital services that are integrated with other hospitals. This is included in the preparation of facilities at hospitals under Law no. 22/1999 which was amended by Law no. 32/2004 which needs to integrate all health data such as health facilities, health promotion, health financing, Health Human Resources (HR), community participation and health management [7]. Furthermore, to support assistance for disaster victims outside the hospital who are affected by the disaster, an integrated communication channel is needed between hospital buildings and between units within the hospital building [8].

In this context, information and communication technology is needed that is accurate, fast and capable of conveying evacuation information quickly through building partitions [9]. The availability of medical personnel, medical equipment and space must also be available immediately. One of the media that can be used is the Public Address System (PAS). Meanwhile, for indoor monitoring [10] in

building units containing inpatients, emergency rooms and laboratories, IoT is needed which functions to monitor the condition of patients and other equipment so that it can run in normal conditions[11]. The novelty in this research is communication in the evacuation and mitigation of disaster victims in the environment around the hospital and within the hospital using a public address (PA) system combined with audio over Ethernet (AoE) and internet of things (IoT) [9] with information display system (IDS) as output in the form of text. Design a PA system network that can be connected to a control microphone with the server switching to another secure unit to ensure the smooth flow of information. Communication networks are also designed to connect to speakers located in the field at a certain distance. Hospital agencies also collaborate with the Meteorology and Geophysics Agency (BMKG) and the Disaster Management Agency (BMKG).

This connection is intended for further post-disaster handling such as predicting aftershocks, disaster management and other assistance. Social media that sends information from affected communities will be received by hospital operator services as well as provide patient referrals to the nearest hospital or hospitals that have complete treatment facilities for further health care. Apart from that, the novelty of this research is the use of IoT in patient care rooms and other important rooms to monitor room availability, medicines, security of medical data and patient conditions.

II. OVERVIEW PAS, AOE, IDS AND IOT

A. *Public Address (PA) System*

A public address system is a system of sound (audio) equipment that is used to convey information or news to service users in the form of audio information, for example announcements of aircraft departures or arrivals at airport terminals. The Public Address System consists of a sound system containing a microphone, mic chime, amplifier and speakers which have been installed in certain places deemed necessary. The design of PA systems in hospitals is very much needed to provide information on the readiness of medical personnel to receive patients who need immediate help. PA Systems are also useful for providing emergency information when a disaster occurs in a hospital during disaster mitigation so that detrimental things do not happen.

Figure 2. PA System Network Controller

In general, Public Address Systems are based on analog networks, then developed into RS485-based hardware addresses using DIP switches. Network limitations based on analog addresses and hardware which result in limited range and signal interference which affects message delivery are problems that are often faced. Meanwhile, hospitals have several units consisting of several buildings which are located far from each room, such as laboratory rooms, treatment rooms, operating rooms and so on. With PA based on an analog network, there will be obstacles in the process. Among them: when the power goes out, there is lightning and the building unit is far away, the network does not function normally. This will hinder the delivery of information from the center thereby disrupting the evacuation process and other rescue actions. With the development of an amplifier-based internet network using audio over Ethernet, this problem can be resolved.

Figure 3. IP based Audio Amplifier

Use of a PA system amplifier based on an Internet Protocol (IP) network using Audio over Ethernet (AoE) technology. This device can communicate with other IP based PA system devices such as PA System Network Controllers as servers, remote microphones or other devices over the network using IP Addresses. Next, the IP addresses are divided into subnets for each different building, IP routes are implemented on Cisco layer 3 switches. This research will be carried out in urban, district, provincial and central hospitals. Remote microphones in different buildings have the same function of conveying emergency announcements and alarms to all zones or zones selected by pressing the zone button on the microphone device.

B. *IDS (Information Display System)*

Information Display System is a data communication system that is designed and has the main function of displaying information. In hospitals, it can generally be used as notification, for example patient visiting hours, notification of rooms being used for surgery, doctors who are carrying out surgical services, etc. via television monitor screens. This information is aimed at visitors who wish to visit patients and patients who will undergo further treatment. The main IDS equipment is a computer device including keyboard, printer and interface card combined with a television monitor, laser disk / VCD player and TV tuner equipment. The design uses the Borland Delphi 7.0 visual programming language.

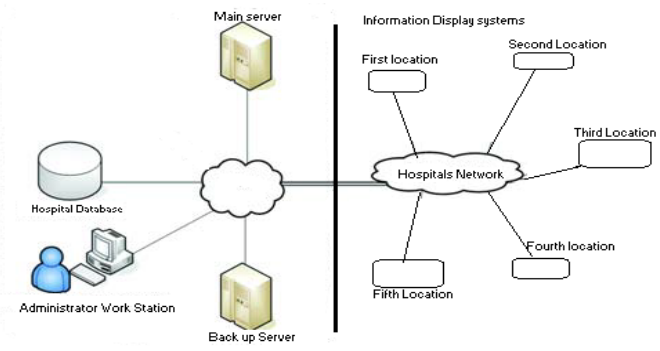


Figure 4. Design for IDS Location

C. *IoT (Internet of Things)*

Internet of things (IoT) is a concept that aims to expand the benefits of internet connectivity to provide conveniences in certain areas such as controlling electronic equipment, rooms, monitoring and many other conveniences obtained from an internet connection [19]. Technological advances support internet-based developments that are controlled by computer devices connected to a network [20]. Currently, smartphone devices have begun to adapt to make changes in replacing the role of computers as control devices and providers of applications like computers. The ease of access and flexibility of smartphones is an added value in replacing the role of stand-alone computers. Furthermore, with the availability of telecommunications services in the form of the internet of things, all human work will be made easier. This also gives birth to a "smart" service model for routine and automatic activities. Examples are: smart home, smart class, smart city and smart hospital [21].

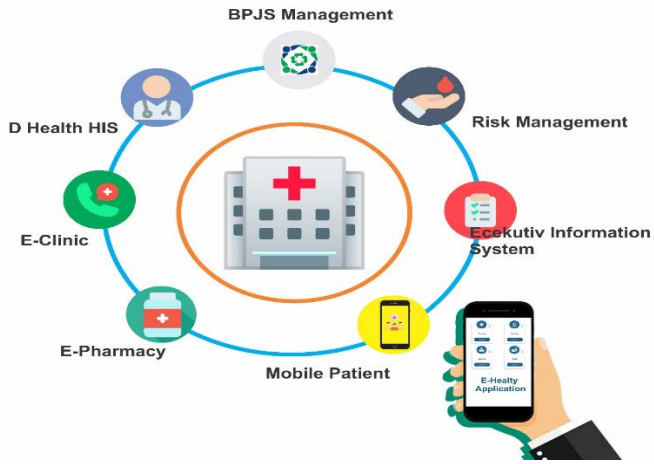


Figure 5. Framework for IoT Hospital

D. *Public Address System, AoE, IDS and IoT Design Architecture*

The public address (PA) systems framework using Audio Over Ethernet combined with IoT can be applied to health care by providing information for monitoring internal units. Next, the information is received by the hospital operator and forwards the information to the party in charge using the public address connected to AoE. The public address architecture using Audio over Ethernet with IoT is divided into two forms, namely the IoT task framework in the room [9] [10] for patient care and the external task framework [11]. The development of external devices is intended to protect and prevent the cessation of health services in hospitals due to disasters with a prevention scenario using the Emergency Help with Public Address (PA) System Design Based on Audio Over Ethernet (AoE), namely VLAN Network Devices as the PA System audio communication path uses layer 3 switches that have IP address segments allocated to PA System devices throughout the desired area. The second scenario is to guarantee indoor health care when an outdoor disaster occurs. The IoT framework describes a protocol for data transmission which consists of room sensors, water level sensors when there is a flood [13] and smoke sensors when there is a fire14]. In each patient room there are also special patient sensors such as: temperature sensors [15], heart rate [16], blood sugar[17], oxygen saturation, etc. which enable health workers to obtain patient health information and can directly monitor health levels from a distance. Far. Information can be sent continuously over the network to the broker responsible for processing and storing acquired data in the cloud.

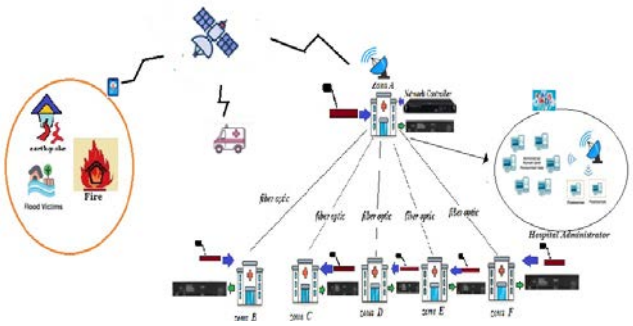


Figure 6. Architecture for Disaster Mitigation and Emergency Help

III. RESULT AND DISCUSSION

The design of the proposed system begins with identifying the number of buildings and units where the AoE system will be built. Next, mapping the number of network requirements by providing IP addressing will be implemented by a PA system that uses an IP-based amplifier that can be connected using a TCP/IP-based computer network. Meanwhile, the audio amplifier can be placed according to needs by assigning IP addresses to the microphone and amplifier. Next, install one IP-based amplifier on each building block to represent a zone registered on the network controller to be connected with a button that can be selected when sending a voice notification [18].

Sending voice messages can be in the form of emergency instructions for the arrival of patients who must immediately receive help or disaster mitigation aimed at emergency building residents or instructions for evacuating patients and important documents therein. Meanwhile, the construction of a network using Fiber Optic cables is intended to facilitate the termination of unwanted electrical currents such as being submerged in floods or lightning strikes on outdoor speakers [12]. Hospitals as the first referral to help critical and emergency victims require immediate treatment by hospital medical personnel. Therefore, the hospital needs equipment to call medical personnel spread across several building units to immediately gather to help patients who have just arrived to get help immediately. For example: fire victims, traffic accidents or critical victims. A Public Address System connected to an amplifier can be a tool used to call medical personnel for emergency announcements, fire alarms, earthquake alarms and other emergency alarms. Internet of Thins (IOT) is installed in the patient room which consists of a room temperature control integrated with CCTV which is managed by the IT unit. Information received by the IT unit will be forwarded to medical personnel as a medical action step if necessary. Furthermore, the unit information section will also provide emergency notifications in the event of a

disaster via a microphone connected to outdoor speakers in the hospital environment. The speaker can be transferred to another zone if the electrical power is cut off due to flooding or lightning strikes. The design of Public Address systems is integrated with display information systems which have previously recorded information according to mitigation scenarios and scenarios. The information to be conveyed will be uploaded and stored on the Web Server system. Next, the IDS monitor which has been integrated with the Web Server system via the internet will access the IDS display data on the monitor provided. This is done to clarify information while minimizing errors in receiving information via voice.

IV. CONCLUSION

The development of an AoE-based public address system combined with Information Display Systems is an addressing system on the internet network with the aim of providing voice and written information by flexibly conditioning the audio center. The audio position settings in the controller position can change according to urgent needs so that health services continue to run normally. The information provided by the operator can be received by other units and can be easily and clearly received by other hospital units. This integration between hospitals and hospital units can provide the possibility of maximum, fast and quality service because each hospital can provide information about the availability of rooms and medical personnel who are ready to serve. The use of IP-based microphones and amplifiers allows the placement of microphones and amplifiers distributed to several room units in a building and sound input can be carried out in different buildings. The implementation of an IP-based PA system provides added value in the form of ease of maintenance, organizational coordination, modification and repair. Meanwhile, the Information Display System is a form of confirming information in written form that provides clarity. Meanwhile, IDS can display foreign language writing according to the information submitted by the operator. The AoE-based public address system currently being designed will be developed in a package that can be integrated with geographical information systems and other internet-based networks in order to receive and distribute more and better quality information.

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