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Website-based teleradiology information systems at disaster locations

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ABSTRACT

Indonesia is a disaster-prone country, be it social, natural, and non-natural disasters. Disasters are usually associated with mass casualties, where health services are an important factor in preventing death, disability, and disease events. Therefore a special health information system in the event of a disaster is needed. One form of health information system is a teleradiology information system used for remote diagnostic imaging. The purpose of this study is the creation of a website-based teleradiology information system at the disaster location as an easy way to interpret radiological images. This type of research uses the Research and Development (R&D) approach of the Borg and Gall method. The sample in this study was 1 radiologist, 2 radiology admins, and 3 radiographers. Expert validation was carried out on the teleradiology information system website design and respondent validation was carried out on website quality and user satisfaction. The result of this research is the teleradiology information system website called "INRASTER" has fulfilled the three main components of teleradiology for disaster. On the results of statistics on the relationship between website quality and user satisfaction variables, the Sig. (2-tailed) < 0.05 which means there is a significant relationship between website quality and user satisfaction. This research concludes that the teleradiology information system website (INRASTER) can be used to facilitate the interpretation of radiological images so that this website can be used during disasters, especially in Indonesian regions.

Keywords: Disasters, Information Systems, Teleradiology, The website.

INTRODUCTION

Disasters are grouped into 3 (three) categories, namely social, natural, and non-natural disasters [1]. The word "disaster" is defined by the International Red Cross as "sudden and dangerous events that seriously disrupt the functioning of a community or community and cause material and economic or environmental human harm that exceeds the ability of the community or community to cope with using its resources [2].

Indonesia is one of the countries prone to disasters social, natural, and non-natural disasters. Social disasters that occur in Indonesia are caused by social and cultural diversity, wherein Indonesia there are around 400 (four hundred) ethnic groups and communities [3, 4]. To unite the differences that exist within the Indonesian people, we need an understanding such as pluralism which views each difference with equality [5].

Natural disasters in Indonesia are caused by the geographical location of Indonesia which is on the three major plates of the world. This has caused

Indonesia to become one of the countries with a high level of natural disasters [6]. The three large plates are the Pacific Plate, the Indo-Australian Plate, the Eurasian Plate, and the smaller plates namely the Caroline Plate and the Philippine Sea Plate [7]. Besides, Indonesia is also located in the Ring of Fire (Ring of Fire), where the Ring of Fire is a location that is often subjected to earthquakes and volcanic eruptions [8]. The Ring of Fire region also results in the high intensity of geological processes on the seabed which can cause tsunamis [9].

While the non-natural disasters that currently hit Indonesia in the form of the COVID-19 pandemic. COVID-19 is caused by SARS-COV2 which belongs to the same large family of coronaviruses as the cause of SARS in 2003, only with different types of viruses. COVID-19 was first reported in Wuhan China, in December 2019, and on January 30, 2020, WHO designated COVID-19 as the Public Health Emergency of International Concern (PHEIC) [10].

These disasters generally have a detrimental effect not only in terms of facilities and infrastructure but also in terms of health. Health services during disasters are the most important factor in preventing death, disability, and disease events. If not handled quickly and appropriately it will hinder, disturb, and cause harm to people's lives. One obstacle that is often encountered in efforts to overcome crises in disaster areas is the lack of Health Human Resources (HR) that can be functioned in handling crises due to disasters. The shortage of health workers can be caused by several factors including health workers that are limited in terms of the number and type of health workers who were victims in the disaster [3].

When a disaster occurs, it is usually associated with mass casualty events. In this mass casualty event, the triage process is very complex [11]. Therefore a special health information system in the event of a disaster is also very much needed [12]. In this research, the information system was studied about the radiological information system. The radiological information system (RIS) plays a role in supporting the operation and work processes in radiology installations [13].

Major advances in telecommunications and computer systems including advances in capturing medical information in the form of digital have accelerated the ability to apply telemedicine methods practically and affordably [14]. One type of telemedicine is teleradiology, where teleradiology is a specialty of the oldest and most widely used clinical telemedicine [15, 16]. The main purpose of teleradiology is to provide various levels of support for remote diagnostic imaging procedures [17].

The development of teleradiology services during disaster events is urgently needed. Three main components are needed in facilitating the provision of teleradiology services during disaster events: the first component is reviewing the existing infrastructure including the existing equipment must be functional and capable of producing diagnostic-quality images, the second component is the ability to obtain, store and transfer images to external sources. Such as laptops, and the third component is the ability to transfer information to remote locations so that reviews and interpretations can be sent quickly [18].

Currently, developing technology also plays a role in efforts to mitigate and manage disasters to be shorter and more practical. One technology that facilitates disaster management is communication via satellite. Communication via satellite channels in outer space will not be affected by disasters. Today the internet is becoming a more effective alternative to communication compared to the telephone. Through an internet connection, the data provided and received will become more accurate as well as when natural disasters occur [19]. One of the internet technologies that is easily accessed by many people in various regions and plays an important role in the delivery of information and communication is the website. The website can provide information to be more efficient and up to date [20].

Based on these reasons, this research will design a website-based teleradiology information system. This design specifically aims to create an information system that is used in a disaster situation; wherein a state of disaster is usually associated with mass casualties, so the speed is needed in handling.

MATERIAL AND METHODS

This type of research uses a Research and Development (R&D) approach with an R&D model developed by Borg and Gall. The R&D steps

according to the Borg and Gall model consist of 10 (ten) steps, but in this study only use 6 (six) steps, namely Research and Information Collecting, Planning, Developing Primary Forms of Products, Preliminary Field Testing, Final Project Revision, and Dissemination and Implementation. The 6 steps are divided into 3 (three) research stages, namely the preliminary study stage, the model development stage, and the model validation stage.

This research has been registered with the Health Research Ethics Commission of Regional General Hospital Prof. Dr. Margono Soekarjo Purwokerto, with Ethical Clearance number: 420 / 01029 / VIII / 2019. This research was conducted at the Regional General Hospital Prof. Dr. Margono Soekarjo Purwokerto. The population in this study was all Radiology Installation staff at Regional General Hospital Prof. Dr. Margono Soekarjo Purwokerto. While the sample of this study was 6 (six) people consisting of 1 (one) radiologist, 2 (two) radiology admins, and 3 (three) radiographers at Regional General Hospital Prof. Dr. Margono Soekarjo Purwokerto. Validation carried out in this research is by designing a teleradiology information system website, then testing the website, and then testing the effectiveness of the website. The research tools used are laptops to design the website of teleradiology information systems and questionnaires used to assess website quality and user satisfaction.

RESULT AND DISCUSSION

Result

Preliminary study stage

In the preliminary study stage, a Focus Group Discussion (FGD) was carried out which resulted in a flow process that was carried out at the time of the disaster. The flow is that the patient is examined at the disaster site, and then demographic data and images sent from the system at the disaster site will be directly entered into the PACS Regional General Hospital Prof. Dr. Margono Soekarjo Purwokerto. From PACS, it can then be accessed to the RIS to be registered with HIS so that the patient is registered as a patient in Regional General Hospital Prof. Dr. Margono Soekarjo Purwokerto.

Model development stage

Based on the flow obtained from the FGD, teleradiology information systems are developed using websites. The teleradiology information system website is called "INRASTER" and this website can also be accessed with the domain name www.inraster.com/sys/. The design of the website information system teleradiology (INRASTER) consists of:

Teleradiology information system model for radiologists

The teleradiology information system for this radiologist can be used to enter examination results (expertise). Only radiologists can enter and change the examination results (expertise).

Teleradiology information system model for radiographers and radiology admins

The teleradiology information system for radiographers and radiology admins can be used to view images and examination results (expertise), it can also be used to add new accounts. Radiographers can send images through XAMPP software.

Teleradiology information system model for clinics

The teleradiology information system for the clinician can only be used to view the image and results of the examination (expertise).

PACS model

All images sent to the teleradiology information system website will be stored in the PACS. PACS in this study uses dcm4chee.

Model validation stage

Spearman Rank Correlation Analysis Results Table

Variable		System Effectiveness	User Satisfaction
Website Quality	Correlation Coefficient	1,000	0,814
	Sig. (2-tailed)	-	0,049
	N	6	6
User Satisfaction	Correlation Coefficient	0,814	1,000
	Sig. (2-tailed)	0,049	-
	N	6	6

User Satisfaction Based on the Spearman Rank Correlation analysis results table it can be seen that the significance value or Sig. (2-tailed) is 0.049, wherein Sig. (2-tailed) 0.049 < 0.05 which means there is a significant relationship between website quality and user satisfaction. The level of strength of the relationship between the effectiveness of the system with user satisfaction can be seen from the correlation coefficient that is equal to 0.814, which means the level of strength of the relationship (correlation) between variables is strong. Meanwhile, to see the direction of the relationship between website quality and user satisfaction seen from a positive correlation coefficient of 0.814, so that the relationship between the two variables is unidirectional, thus it can be interpreted that increasing the value of the website quality will increase user satisfaction.

FLOW CHART

The flow chart of this website-based teleradiology information system, starting from the radiographer doing a radiological examination at the disaster site, then the image from the results of the examination are inputted to the teleradiology information system website (INRASTER). Furthermore, the radiologist can see and evaluate the image whether additional examinations are needed or not, if additional examinations are needed the radiographer will reconduct the radiological examination and input the image into the website. If the radiologist does not need additional tests, the radiologist can immediately carry out expertise results on the website. Then both the radiographer at the disaster site and the clinician can see the image and expertise results of the examination. After all the images are performed expertly, the radiology admin can make a report on the results of the examination.

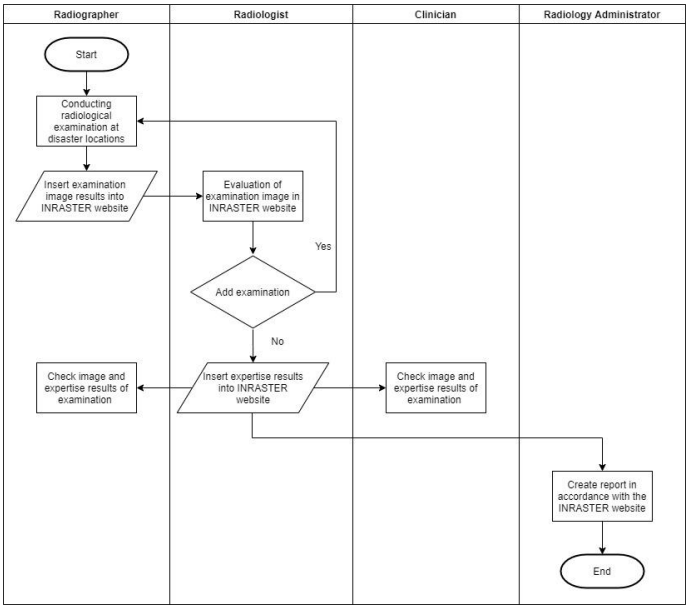

Figure Teleradiology Information System Flow Chart

DISCUSSION

Preliminary study stage

In this study, it was limited to designing teleradiological information systems and PACS, where demographic data and images from disaster locations were sent into PACS. Furthermore, so patients can be registered as patients of Prof. Hospital Dr. Margono Soekarjo Purwokerto, in this study is still done manually through patient demographic data in the teleradiology information system inputted into RIS so that it can be accessed at Regional General Hospital Prof. Dr. Margono Soekarjo Purwokerto. This can be seen from the teleradiology information system flow diagram where the radiology admin cannot access RIS directly, so the workflow management for the radiology admin has not been efficient.

Although this teleradiology information system has not been integrated with the RIS and HIS of Regional General Hospital Prof. Dr. Margono Soekarjo Purwokerto, the results of the research on the teleradiology information system website have been integrated with PACS. With the advances in radiology informatics including the integration of PACS and RIS it has improved installation efficiency. The fundamental advantage of this system lies in its ability to store large amounts of data that is easily accessible and to reduce workflows through eliminating steps that are not needed beforehand, besides this system makes workflow management efficient, and facilitates fast communication [21].

Model development stage

At the development stage of the model, a teleradiological information system design pathway integrated with PACS is obtained; this is in line with advances in radiology informatics including the integration of PACS and radiological information systems (RIS) which have improved installation efficiency [21]. The form of workflow efficiency improvement with this integration is that it can accelerate the steps in handling patients where patients who have been carried out radiological examinations at disaster locations are then referred to hospitals so with these teleradiology information system patients no longer need to re-examine radiology installations hospital so that the patient can be given immediate follow-up care when he/she arrives at the hospital. Besides, one of the other forms of workflow efficiency improvement is that clinicians can directly see the image of examination results and expertise on the website, so there is no need for physical films and expertise and this can reduce the radiology installation workflow and save costs.

Model validation stage

The teleradiology information system design has fulfilled the three main components of teleradiology for disaster. In the first component of teleradiology for disaster, functional equipment and adequate infrastructure are needed [18]. In this study, the first component has been fulfilled with the design of the teleradiology information system, where the teleradiology information system can be categorized as a functional tool in facilitating the installation of radiology to interpret images based on the results of user satisfaction test of teleradiology information systems.

The second component of teleradiology for disaster is the ability to transfer images to external sources such as laptops [18]. The second component has been fulfilled in this study demonstrated by the use of research tools such as laptops. Laptops are used to send images to teleradiological information system websites.

The third component of teleradiology for disaster is the ability to transfer information to remote locations which include data transfer using satellites or cellular networks, a password-protected web-based platform for viewing images remotely, and there must be a radiologist to view these images and provide reports within a reasonable period of time [18]. This third component has also been fulfilled in this research, namely the need for internet use. Where one internet technology that is easily accessed by many people in various regions and is very instrumental in the delivery of information and communication is the website [20]. This teleradiology information system is also a website based on the domain name www.inraster.com/sys/ so that this teleradiology information system can be accessed anywhere during a disaster. The teleradiology information system website can also be developed according to user needs, this is because the software used in designing this website is open source.

Based on the test of the relationship between website quality and user satisfaction there is a very strong relationship between website quality and user satisfaction. So it can be concluded that this

website-based teleradiology information system can be applied to facilitate the installation of radiology in interpreting images during disasters.

CONCLUSIONS

Based on the results of research that has been carried out, the following conclusions are obtained: In general, the purpose of this research has been achieved, namely the establishment of a website-based teleradiology information system that can be used to facilitate the interpretation of radiological images during disasters, this is indicated by the fulfilment of three main components of teleradiology for disasters. Specifically, the objectives of this research have also been achieved in addition to developing the system, another goal is to conduct trials and assess effectiveness. As is well known based on the assessment of the effectiveness of the teleradiology information system website (INRASTER) this can be used to significantly improve services during a disaster.

RECOMMENDATION

After researching a website-based teleradiology information system at the disaster location, the suggestion for this research is:

1. The next researcher can conduct research related to image compression if the images are combined on the website, it is hoped that the merging of images on the website can accelerate the process of image interpretation.
2. Further researchers can also link this teleradiology system with RIS and HIS of Regional General Hospital Prof. Dr. Margono Soekarjo Purwokerto, so that disaster victims can be registered as Regional General Hospital Prof. Dr. Margono Soekarjo Purwokerto patient is automatically no longer manually as in this study.

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