

The Development of an intelligent e-health Mobile Application in Indonesia: A Preliminary Study

Yasser Abd Djawad¹, Sutarsi Suhaeb¹, Ridwansyah Mustakim¹, Hendra Jaya¹,
Saharuddin Ronge¹ and Saliruddin Sakka¹

Abstract— Telehealth has developed as an alternative to cover healthcare in all regions. Telehealth technology cannot be separated from Information and Communication Technology (ICT) that has been infiltrated to human activities nowadays. Internet and mobile phone technologies in Indonesia have become new major needs. Indonesian Government and some institutions have tried to use these technologies in healthcare services in some remote areas. However, some obstacles have been found in the implementation of the technologies such as inadequate ICT infrastructure and lack of policies about healthcare for remote areas. The study was conducted to obtain the recent status of the telehealth in Indonesia to develop a simple and proper mobile application. A literature study was conducted by collecting relevant information such as reports, regulations and policies released by the Indonesia Government regarding the healthcare infrastructures and latest technology used for telehealth. In addition, updated information from various institutions was also collected. The study reveals that there has been a gradual increase in the number of healthcare infrastructures in some remote areas in Indonesia. The number of ICT infrastructures is also expected to increase every year to facilitate communities in remote areas to be connected with others. Therefore, a mobile model of telehealth using text message services would be designed as a development model based on previous models that have been designed by some researchers.

Keywords—healthcare, ICT, telehealth

I. INTRODUCTION

Indonesia is an archipelagic country which consists of many islands. This condition results in disadvantages in terms of infrastructure development such as ICT and transportation, including health facilities. In many remote islands and areas, people are struggling to obtain healthcare. Therefore, to overcome the healthcare problems, Indonesia has been using telehealth since around 2009. Some development and improvement have been made. Some Indonesian researchers have tried to study and apply the telehealth in Indonesia. The development of telehealth in Indonesia described in [1]. Two applications of telehealth system that would be implemented in Indonesia discussed in [2]. The applications were automated heartbeat prediction using Tele-ECG (Tele- Electrocardiography) and an application to detect a fetus through an ultrasound image based on Tele-USG (Ultra Sonography). These applications used a smartphone to transfer data to a server for saving and analyzing purpose. Before applying the telehealth system, [3] conducted a study to obtain the perceptions of nurses in the case of cardiovascular disease treatment in terms of using the

telehealth system. An integrated e-prescription system to be applied in a Community Health Centre (CHC) to avoid vacancy of drugs promoted in [1]. As mobile users increase, [4] utilized mobile phones to make an application to promote healthcare for mother and child. Development of a mobile application for monitoring and consultation for hypertension patients discussed in [5]. Some mobile applications for telehealth have been introduced by Indonesian researchers [6]. However, all reviewed previous studies so far have not used a common application such as Short Message Service (SMS) and artificial intelligence to predict common diseases. The aim of this study was to review the development of telehealth and to obtain the use of ICT for telehealth in Indonesia. The particular objectives of this study are to obtain a detailed overview of the current profile of general health and ICT in Indonesia; to reveal, parse and evaluate the barriers and problems of telehealth in Indonesia; and to suggest proposed actions for the development of telehealth in Indonesia.

II. METHODS

The review of the development of telehealth in Indonesia was guided by [7] which following steps were taken: subject selection, search strategy, databases and analysis.

A. Subject selection

These were the selected subjects for this study: (1) recent health infrastructure development in Indonesia; (2) recent ICT infrastructure development in Indonesia; (3) recent telehealth studies in Indonesia; (4) latest technology used for telehealth; (5) reports and articles published between 2000-2017; (5) telehealth studies published in English; (6) health and ICT reports or news published in Indonesian Language.

B. Subject selection

The study was conducted by collecting reports and articles from various official institutions and researchers on the Internet. These sources were reviewed and analysed to gain updated information. In order to find literature, ECLIPSE method was used since this method is fit for health management and policy searches [8]. This literature searching method consist of 6 questions: (E) Expectation; (C) Client group; (L) Location; (I) Impact; (P) Professionals; (SE) Service. Expectation (E) of this study was to review and evaluate the development of telehealth in Indonesia, the Client group (C) was the Indonesian citizens, Location (L) was in the territory of Indonesia, Impact (I) was the health infrastructure and ICT infrastructure ;Professionals (P) was the health workers; Service (SE) was the health service.

¹ Universitas Negeri Makassar (e-mail: yasser.djawad@unm.ac.id, sutarsisuhaeb@yahoo.co.id, ridwansyah@unm.ac.id, hendra070982@gmail.com, sahar_ronge@yahoo.com, saliruddin48@yahoo.co.id)
Corresponding author: Yasser Abd Djawad

C. Databases

The reports used in this study were obtained from ministries, National Bureaus and official organisation in Indonesia. In addition, to enrich the data, some reports from some official world organisations that reported through the Internet and news were also observed and reviewed. Articles from previous research were reviewed and analysed to gain knowledge and the latest research in this field. Following electronic bibliographic databases were used: PubMed, Scopus, DOAJ and Google Scholar.

D. Analysis

The analysis used in this study was a descriptive analysis which was based on the quantitative approach. The descriptive analysis was conducted based on the findings of the reports and articles from searching results.

III. RESULTS AND DISCUSSION

A. Profiles of General health

General indicators of health status in Indonesia have improved positively over the last and two decades. Life expectancy is increasing within period 2010-2017. In 2010, the life expectancy was 69.81 years old while in 2017, the number was 71.06 years old and the number of infant mortality cases is also decreased from 33,278 in 2015 to 32,007 in 2016 [9]. However, the number of deaths due to disease is still high. According to the Sample Registration System survey in 2014 by the Ministry of Health (MoH) [10], showed that coronary heart disease (CHD) was the highest cause of death at all ages after stroke. While Dengue fever (DB) and tuberculosis (TB) showed an increasing trend during the period of 2012-2016. One reason why the number of deaths due to disease is still high because Indonesian people still have less awareness of health expenditures. The report [11] revealed that expenditure as % of GDP for health in 2015 was 3.29% which is quite small compared to non-food expenditure such as housing facility (20.75%), fast food (13.37%) and goods and services (12.35%).

Improving quality accessibility, services and health facilities for the people is one of the main focuses in Indonesian government policy. Therefore, the health facilities are gradually improved. The number of CHC is slightly increased every year as shown in Fig 1. However, the ratio of CHC numbers to the number of 30.000 population decreased in 2015 [11]. Even though in some islands, the ratio was higher because they had less population. In 2015, there were 2.488 hospitals including state and private hospitals. This number consists of general and special hospitals. General hospitals provide services for all illnesses and diseases. Meanwhile, special hospitals provide services only for special kind of illnesses or diseases in a human organ. However, one of the main problems in the Indonesian hospitals is the services. The services are including admission of patient in the general polyclinic or Intensive Care Unit (ICU), health worker services and complex of the payment system. The hospital management should evaluate the business process to provide better services to patients.

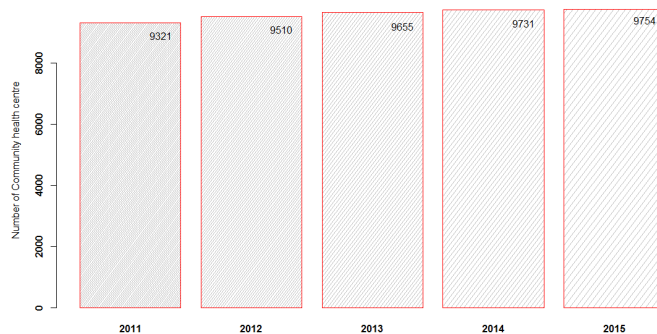


Fig. 1. Number of Community Health Centres by year. Data provided by Ministry of Health in Indonesian Health Profile 2015 [11]

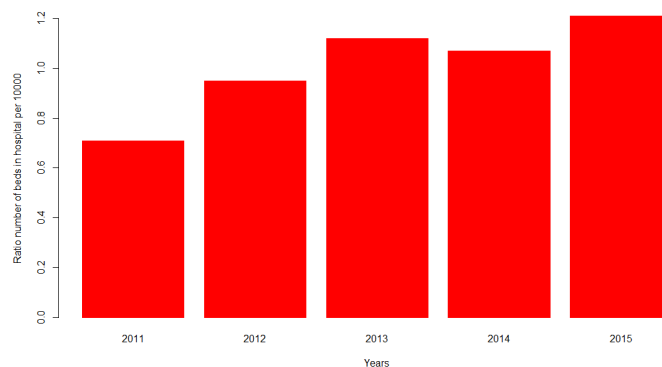


Fig. 2. Ratio of number of beds in hospital per 1000 people. Data provided by Ministry of Health in Indonesian Health Profile 2015 [11]

The increasing number of hospitals should be followed by the number of available beds. The ratio of the number of beds in the hospital per 1000 people was slightly increasing by year and that number of beds in the hospital was fairly enough as shown in Fig 2.

However, some provinces such as Banten, Nusa Tenggara Timur, Lampung, West Java, West Sulawesi and Nusa Tenggara Barat did not have enough beds in hospitals. Thus, the ratio was below 1. Another problems faced is because all hospitals are located in main cities, districts and the capitals of provinces. While the CHCs are located in subdistricts. When people in rural and remote areas need healthcare, they should go to the CHC first which it takes at least an hour from rural and remote areas. Even in some areas, it takes one day to reach CHCs in subdistrict because less of transportation infrastructure. If they need further and better cares, the CHC recommend them to hospitals in the district, capital cities, provinces or hospital in the main cities. This causes the community needs a high cost to obtain health services. However, the problem faced by communities in CHS is the lack of service by CHCs including the lack of health workers, medical health devices and working hours. The telehealth system is needed to reduce the number of referred patients from rural and remote areas that have been checked by a nurse who sent by the CHC to the hospitals. Thus, the system can reduce the number of people who stay in hospitals and can save the cost of health care that has to be paid by poor people.

Another problem faced by communities in Indonesia is CHCs should have 5 types of health workers: pharmacy, public health, environmental health, nutrition and medical laboratory technician. However, in 2017, only 2.641 CHCs had these 5 types of health workers from 9.821 of existing CHCs [11]. On the same side, the health workers ratio indicates the availability of health workers to serve communities. In Indonesia, the health workers ratio is still lower than the recommendation by the Ministry of Health (MoH) [11]. Another health facility needed by the community is the availability of medicines and vaccines at the CHCs. In order to ensure basic health care, the government ensures the availability of medicines and vaccines by observing 20 items of medicines and vaccines in CHCs. According to the Directorate of Pharmacy and Health Devices, in 2015, 79.38% of basic medicines and vaccines were available at the CHCs [12]. The problem faced by the MoH is the lack of coordination with provincial authorities caused by incomplete and inaccurate reports sent by provincial authorities. This results in incomplete data on the availability of drugs and vaccines in the province and can lead to a lack of medicines and vaccines in some rural and remote areas which can cause high mortality and outbreaks.

B. Profiles of ICT

Telehealth is a system that provides healthcare using Information and Communication Technologies (ICT), including patient care, administrative activities, data exchange and health education. Telehealth was mainly made to expand healthcare to all regions. Telehealth should have three features; real-time, store and forward and remote patient monitoring [13]. In order to fulfil the requested features, previous studies used different ICT technologies to apply telehealth. [14], [15],[16] used a telephone as a media for transmitting, monitoring and communicating the medical care results. Meanwhile, [17],[15] used video-phone for monitoring the patients. Internet-based telehealth system was used by [18], [19],[20] to exchange information between patients and healthcare providers.

Indonesia has a lot of rural dan remote areas which have less transportation infrastructure. However, in those rural and remote areas, mobile telecommunication infrastructures have been installed. Fig. 3 and 4 show the coverage area of two mobile phone providers (Telkomsel and Indosat) [21]. The figures show the distribution of BTS (Base Transceiver Station) using 3G and 4G technology that can provide Internet access to users in all regions in Indonesia. Fig. 3 shows that the distribution of BTS by Telkomsel which coverage areas is mainly in Java island where the most population are living. In the eastern part of Indonesia, the number of BTS is mostly in the towns and many regions are not covered. However, Telkomsel claims that the provider has installed 480 BTS in the outer islands that can also use 3G technology for accessing Internet [22]. Another figure from Indosat is shown in Fig. 4. A similar case is shown, in which most of the BTSs are installed on Java island; in many parts of Indonesia, they have not been installed. In order to reach telecommunication minimum service for people of Indonesia, the government should encourage the mobile phone providers

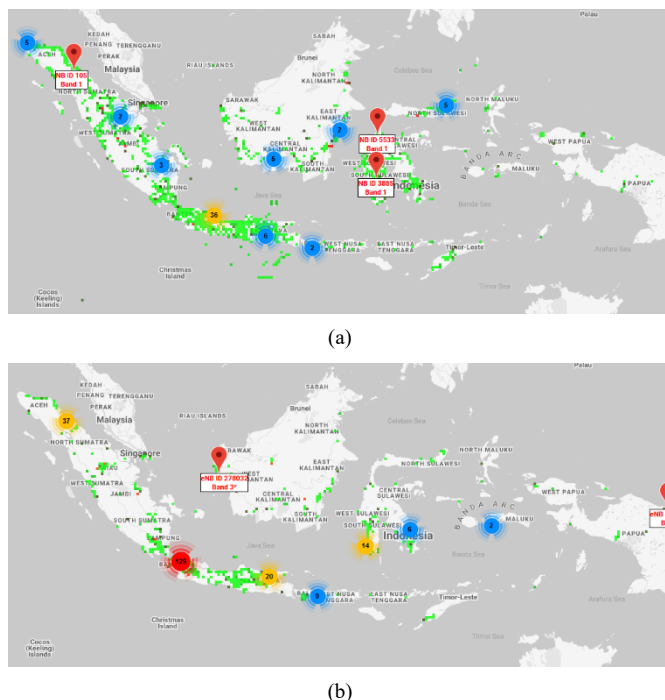


Fig. 3. Coverage area of (a) 3G (b) 4G service by Telkomsel [21]

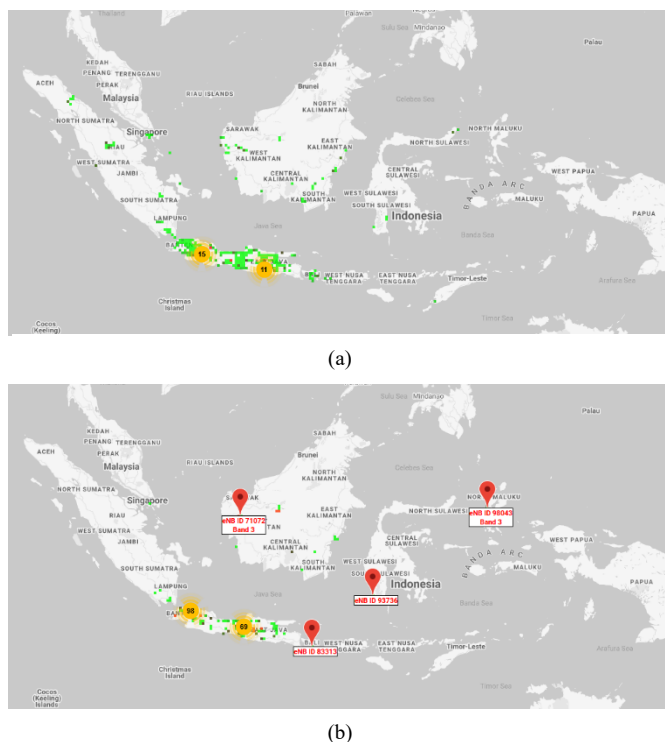


Fig. 4. Coverage area of (a) 3G (b) 4G service by Indosat [21]

to install more BTS that support minimum 3G technology in rural and remote areas to access the Internet. This is also used to connect all islands as unity. The latest report named "Digital In 2017 Growth Overview" released in January 2017 [23]. The report revealed the statistics and trends of the Internet usage for 239 countries around the world. The report showed that Indonesia was the fastest growing country of Internet users year-on-year compared to 2016 as shown in Fig. 5. The growth year-on-year is 51% which was the

biggest growth compared to the global average growth at 10%. On average, in terms of fixed Internet connection speeds, Indonesia had 6.4 MBps which was slightly better than the average 6.3 MBps. In addition, the average mobile connection speeds in MBps in Indonesia was 10.9. Meanwhile, Indonesian people spent 08.44 hours on the Internet per day using laptop/pc and 3.55 hours using the mobile device.

A report issued in 2016 by the Association of Indonesian Internet Providers (APJII) [24] indicated that Indonesia had around 132.7 million internet users. The report said that 65% of 132.7 million or 86.3 million Internet users were in Java island where most of the population was located, followed by Sumatera that had 15.7%. Other islands had only less than 7% of Internet user penetration as shown in Fig. 6. This graphs also describes the development in Indonesia where islands outside Java were less developed such as Maluku and Papua. Therefore, sustainable development to facilitate healthcare is needed including ICT development since most of the rural and remote areas are located in outside Java island. In addition, [24] revealed that Indonesia has 371.4 million mobile subscriptions which reveal that some people had more than one mobile subscriptions since the population is about 262 million.

The data explained that health services have not distributed well yet. Meanwhile, mobile technology has spread widely in Indonesia. Even though in some rural and remote areas, the proper telecommunication infrastructure has not been installed yet. ICT has been adopted in the people daily life. It shows that mobile device is a common device in their daily activity and, therefore, it is a great challenge to create a telehealth model based on the mobile device application.

A new innovative telehealth-based on a mobile device should provide a powerful method of home healthcare services in terms of integrity, reliability and ease. The home healthcare services based on the mobile device should overcome lacks of healthcare services in remote and rural areas since it widely spread and the average connection speed of mobile internet connection in Indonesia is enough. The results of healthcare services can be recorded for medical use. A machine learning (ML) feature would be introduced to help patients and doctors to get the disease prediction sooner. In addition, the doctors and health providers would be helped to prepare the action regarding the ML prediction. This mobile application can be downloaded and used by anyone privatively, which included health education about preventive efforts from illnesses or outbreaks.

The proposed application for healthcare would use a mobile application. Since in the remote and rural areas lacks health facilities and health devices, the mobile application only needs an input of symptoms of the disease. The given symptoms would be sent to a server to be processed and analysed by an ML program. The program predicts the diseases based on the given symptoms and returns the result to the patient. In the case where the diseases are not recognised by the program, the data will be transferred to a health provider to be analysed by a doctor. After the data are processed, an action is needed if the patient needs a treatment.

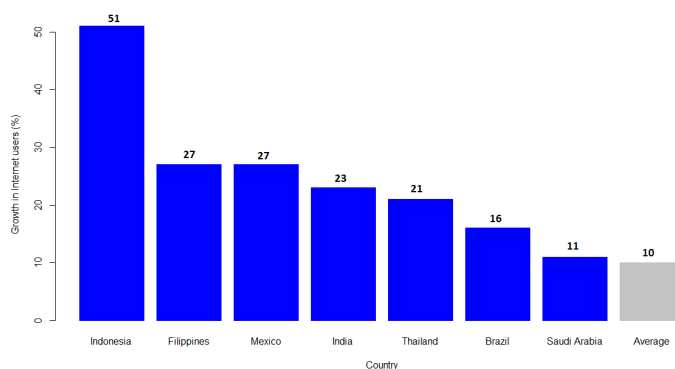


Fig. 5. Growth in Internet user by country. Data provided by [23].

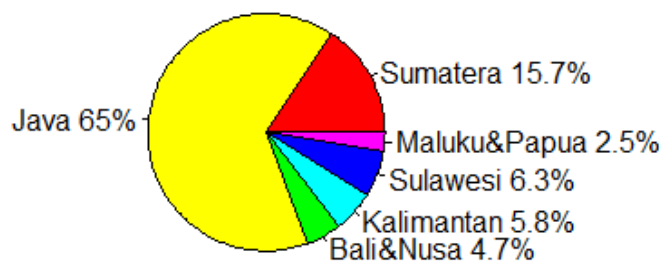


Fig. 6. Number of internet user penetration distributed by islands. Data provided by the Association of Indonesian Internet Providers (APJII) [24].

A doctor or nurse is expected to come to conduct an examination of the disease and bring some drugs. Therefore, the medical staffs and medicines should be available in CHC to serve the patient if needed. The proposed e-health mobile application should be able also to place a prescription at CHC for patients who stay in remote and rural areas to ensure that they also get medical care. In addition, information about alternative treatments for patients such as herbal medicine should be provided by the mobile application.

It is hoped that telehealth through this mobile application, in general, can encourage an improved communication between patients, health workers and national policymakers to improve health services in rural and remote areas. The use of telehealth will have an impact on the capacity building of rural communities to use ICT in their daily lives and enhance some aspects of health services and education such as:

1. Telehealth will enhance linkage between health institution, government bodies and community organisations to review and renew health policy for national development.
2. Establishment of interconnected health providers with rural communities that will enhance health providers access to contribute for improving healthcare services in rural and remote areas.
3. The telehealth mobile application encourages people to manage their own healthy life independently either in direct interaction with health workers through the mobile application or indirect way by collaboration with the local communities to have a group to enhance their participation for improving their healthy life using the mobile application.

4. The telehealth mobile application will be linked to health partners websites extending the reach of information dissemination and enhance knowledge people in the rural and remote areas.

A pilot project should be made to assess the use of this mobile application. The pilot project should be conducted in a remote area first to evaluate feasibility, time and cost and general performance overview of the use of this mobile application. Based on the result of this pilot project, an improved mobile application system has to be made. Afterwards, the researchers should disseminate information on application availability with collaboration through the MoH, the Ministry of Communication and Information, local authorities and telecommunication providers. The information should be spread to CHCs, Non-Government Organisation (NGO) and communities association to deliver the mobile application to people in rural and remote areas by providing social dialogue, technical and economic assistance to ensure a better understanding of the mobile application usage.

The use of telehealth mobile application will ensure sustainability efforts as following:

1. The fulfilled form of mobile application would be used as a patient digital medical record that can be used by health providers or the MoH for monitoring outbreaks in rural and remote areas.
2. Digital medical records generated by the mobile application can be used by national policymakers to support the social and economic development of rural and remote areas.

With the support of proper ICT infrastructure, telehealth is expected to deliver health service for helping Indonesian people in the rural and remote areas that have fewer health facilities and transportation infrastructure. The use of ICT in healthcare can enhance capacity buildings of the local communities which generate human resource with health knowledge. It is hoped that with the well-educated human resource can improve their social and economic incomes.

IV. CONCLUSION

Healthcare is one of the essential needs of human beings besides clothing, housing and food. Healthcare provides services to maintain human health, to prevent human from diseases or outbreaks and to cure them. This includes biological and physiological healthcare. In big cities, healthcare is not a big problem because health facilities, health workers and doctors are available. However, in many remote and rural areas, healthcare is extremely sparse. Another problem faced is that the increasing the number of residents is not accompanied by the increase in the number of beds in hospitals. This problem caused many people not to obtain maximum healthcare. Various ICT technologies have been introduced to overcome the lacks of healthcare in some areas in Indonesia. However, a different approach and model should be designed and proposed as the development of previous methods, which can be integrated into the current healthcare services. The proposed approaches and model should be mobile-based as this technology has spread widely to rural and remote areas. The model also has to rely on

societal aspects of the local communities. In the future, telehealth has a potential role with great benefits to improve health care and to educate people that can increase the capacity building of the local communities.

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