
An Overview of e-Health in Indonesia: Past and Present Applications

Dwi Cahya Astriya Nugraha¹, Ismiarta Aknuranda²

Faculty of Computer Science, Brawijaya University

Article Info

Article history:

Received Nov 17, 2016

Revised Jan 3, 2017

Accepted Apr 11, 2017

Keywords:

e-Health
e-Health application
Indonesia

ABSTRACT

Indonesia is the largest archipelagic country in the world. There are five major islands and thousands of smaller islands, most of which are in the distance. Therefore, its health services are hardly distributed. E-Health is one of the methods expected to deal with the problem of distance in health services. The development and use of technology in health area has given rise to several studies on the applications of e-Health in Indonesia. Based on a number of studies, we find that e-Health in Indonesia has been applied since 1985. The technologies and features used from time to time were growing in some period of time. However, the study also shows that from that point of time the number and variety of technologies and features provided are decreasing and the focus shifted to further analysis of the problems needed to be solved and provision of technologies and features only relevant to those problems. The development of e-Health applications in Indonesia has given promising results in providing health services, but they are still conducted by certain educational institutions and their uses are not evenly distributed throughout Indonesia.

Copyright © 2017 Institute of Advanced Engineering and Science.
All rights reserved.

Corresponding Author:

Dwi Cahya Astriya Nugraha,
Faculty of Computer Science,
Brawijaya University,
8 Veteran Road, Malang, East Java 65145, Indonesia.
Email: astriyanugraha@gmail.com

1. INTRODUCTION

Indonesia is the biggest state of islands in the world with 17,508 islands and populated with 222 million inhabitants in 2006. It promotes Indonesia to be the fourth most populated country in the world [1]. The islands of Indonesia are separated by sea and most of them are in distant. Therefore, health service is hardly distributed. Health service is still hardly provided on remote islands such as Anambas Islands and Natuna Regency with weather and distance are the main causal factors [2]. The advance of technology of communication and information has influenced the development of Indonesia, including health development that involves infrastructure and information facility. One method to deal with the problem of distance in health service is using e-health [3].

E-Health refers to the use of ICT (Information and Communication Technologies) to help the performance of the people and enable to receive health care services more efficiently, effectively, and safely [6]. E-Health is also a system that refers to the ease of the process of retrieving and exchanging health data personal between hospitals and medical centers [7]. E-Health using ICT along with the principle of e-commerce and e-business to change the way the delivery of health services [8]. E-health is a health service using the application of technology of information and communication to connect with the entire functional elements that support health sector. E-health accommodates several services such as electronic health record (EHR), telemedicine, consumer health informatics, health knowledge management, virtual health care team,

mobile health, health care information systems, etc [4]. E-health applications required various technologies to support their implementations, for example telemedicine applications that claim to be multimedia required a visual cryptographic methodology which efficient, reliable, and effectively focuses on the encryption and decryption of the two-dimensional DICOM standard compressed medical image [23], a low cost and high independent scalability telemedicine infrastructure required the merits of 802.11s as the wireless mesh network standard [24], telemedicine based on mobile device required Mobile Cloud Computing (MCC) that integrates the cloud computing into the mobile environment to extends mobile devices' battery lifetime, improves their data storage capacity and processing power, and improves their reliability and information security [25], telemonitoring required primary communication that based on transferring several vital signals simultaneously and continuously to monitoring physiological parameters such as heart rate, blood pressure, oximetry and others signal [24], etc. Requirements on telemedicine services are widely, it is depend on application type and approach of devices data acquisition [24]. Telehealth also represents the part of e-health and is used as the instrument to monitor long-term condition of the community by actively monitoring the condition of patients. Monitoring vital signs are believed to reduce the hospitalization [5].

The development of the use of technology in health field gives rise to several studies on the application of e-Health in Indonesia. This paper discusses the development of e-Health applications from time to time in Indonesia. The discussion is expected to provide an overview of e-Health applications development in Indonesia to resolve the spread of the quality of health services in Indonesia.

The paper is organized as follows: Section 2 explains the methodology that used in this research, results and analysis are presented in Section 3, hereafter, past and present application of e-health in Indonesia is discussed in Section 4, then based on the analysis and discussion, a conclusion is made on the state of past and present application of e-health in Indonesia and direction for possible further research in Section 5.

2. METHODOLOGY

The methodology in this study is adapted from framework for literature reviewing by vom Brocke [26] as illustrated in figure 1. Accordingly, the outset of the study was a definition of the review scope that describes in Section 1. The definiton of review scope was followed by a conceptualisation of topic, literature search, literature analysis, and research agenda that comprised more insightful questions for future research.

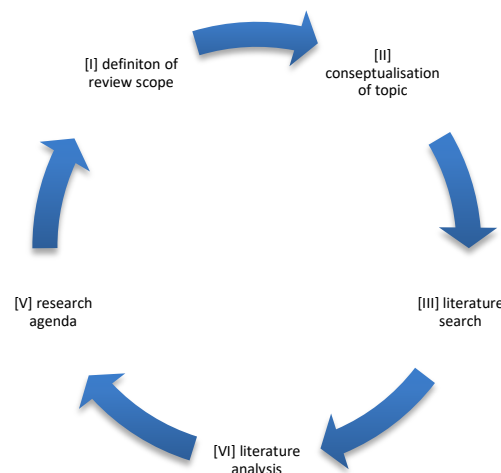


Figure 1. Methodology adapted from framework for literature reviewing by vom Brocke [26]

Review scope of this study is e-Health application in Indonesia and the topic is the development of e-Health applications from time to time in Indonesia. After establishing the first step and second step, the next step was to conduct the literature search as described in the following.

a. Literature Search

We collect research conducted in all years. The keywords we use are “e-health Indonesia”, “telehealth Indonesia”, and “telemedicine Indonesia”. International papers on e-health applications in Indonesia is difficult to obtain, therefore the search is not limited to the English language papers but also Indonesian language papers relevant to the topic. A search of English language papers was conducted in IEEE, Springer, ScienceDirect, and Elsevier. A search of Indonesian language ones was conducted in

Indonesian Publication Index (IPI) and Garuda Dikti. The criteria to not include an article in this study are those that have no relevant information to the topic, full-text papers that cannot be obtained, and papers that do not provide detailed information on the application of e-health in Indonesia.

The search process and result of obtaining these references are shown in Figure 2. As many as 232 national papers and international papers are identified. From the number, we collect twenty papers relevant to the application of e-Health in Indonesia. Then, after being screened, as many as fourteen papers were included in this study.

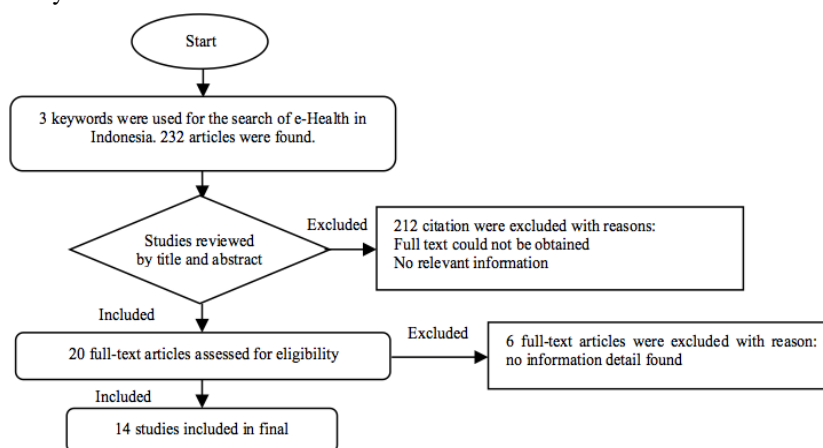


Figure 2. Literature search process

The determination relevance of individual papers to this study is by analyzed the title of each paper. If the researcher in doubt, the papers were further analyzed by analyze the abstract. The corresponding title and abstract of each paper was necessary to further analyze the text body and then studied the entire contents of the papers. By analyzing the title, abstract then entire contents of the papers, the researcher obtained the appropriate paper for inclusion in the study.

3. RESULTS AND ANALYSIS

The fourteen papers studied in this research show the development of e-Health applications from 1985 to 2014. List of papers studied in this research can be seen in Table 1.

Table 1. Fourteen Studies Included in Final

Authors	Year Publication	Year Activity E-Health in Indonesia That Explain in Paper
Irawan and Soegijoko	1997	1997
Lun	1999	1999
Nakajima et al.	2001	2001
Pambudi et al.	2003	2003
Suksmono et al.	2004	1985-1987, 1990s, 1992-1997, 1999, 2004
Husni et al.	2007	2007,
Lucas	2008	2008
Soegijoko	2009	2005, 2004-2006, 2009
Shimizu et al.	2009	2006
Soegijoko	2010	2010
Setyono et al.	2011	2011
Soegijoko et al.	2011	2011
Mardiyanto et al.	2013	2013
Grayman	2014	2014

Several e-Health applications have been made since 1985 and have facilitated health service in Indonesia regardless the fact that Indonesia comprises of islands separated by sea and huge distance. Thus, e-health has allowed physicians and patients to deliver and receive health service, respectively. The presence of e-Health also helps patients in remote area from unnecessarily going to the town just for making appointment with the specialist. Also, the specialist in town may not necessarily break through remote area only to diagnose the patient. As been recognized, e-health can increase the efficiency of timing and distance. This research provides a description of the development of e-health application throughout Indonesia regions.

Some applications of e-health in Indonesia have used PC and mobile phone platforms. Each of e-health applications in Indonesia from 1985 to 2014 have variety of information exchange medias to transmit data and have variety of technologies and features in using e-Health application but there are some years that were not explained. Information exchange medias, technology, and features on e-health from 1985 to 2014 are shown in Table 2, Table 3, and Table 4 respectively.

Table 2. Information exchange medias on e-health

Year Activity	Information Exchange
1985-1987	Teleconference, text
1990s	Image transmission
1992-1997	Video streaming, Television conference
1999	No explanation
2001	No explanation
2003	Radio packet communication systems, email
2004	Videophone, Video streaming, SMS (Short Messaging Systems)
2005	No explanation
2004-2006	No explanation
2006	Teleconference, video streaming
2007	No explanation
2008	Telephone services, email, fax
2009	SMS (short Messaging Service)
2010	SMS (short Messaging Service), Email, Online Chat, Videophone
2011	Audio and video streaming, SMS (Short messaging systems)
2013	No explanation
2014	Email, Telephone

Table 3. Technology used on e-Health

Year Activity	Technology used
1985-1987	Satellite-based
1990s	Image transmission with narrowband, Image processing
1992-1997	ETS-V L-Band transmission, Satellite-based, Wireless, Link Satellite JCSAT, ISDN, Tele-data
1999	Web-based
2001	Communication satellite
2003	Internet radio packet, Automatic Distributed Synchronizing Data Base System
2004	New Coding image C-S based on wavelet, internet based, Wireless Access Protocol (WAP)
2005	SMS server, Multi communication links
2004-2006	Wireless LAN
2006	DVTS (Digital video transport systems)
2007	Mobile internet protocol version 6 (MIPv6) combine with network based on mobile adhoc network (MANET), wireless LAN IEEE 802.11
2008	Use Tele-center concept, internet
2009	Internet ADSL, Paperless prescription with ADEs (adverse drug events), SMS based alert
2010	Store-and-forward, LAN, Internet network, mobile phone network, Modem, mobile phone that connected to the PC, Use arbiter module, Image processing based
2011	Multimedia messaging service (MMS), SMS engine Gammu
2013	Modulation filtering
2014	Internet network, phone network

Table 4. Feature of e-Health

Year Activity	Features
1985-1987	No explanation
1990s	No explanation
1992-1997	Medical education, medical communication, Maternal health services, PC-based Ultrasonic heart rate fetal monitor, PC-based sphygmomanometer, PC-based electronic scale
1999	No explanation
2001	No explanation
2003	No explanation
2004	Tele-consultation, Tele-diagnosis, Tele-coordination, Tele-education, Drug database, Tele-biomechanics, Tele-consultation, Tele-education
2005	Outbreak management, Reporting, monitoring, Transfer ECG signal, blood pressure, temperature, SpO2
2004-2006	Medical information transfer
2006	Surgery
2007	Tele-emergency, Electrodiagram digital (ECG), Oxymeter (SpO2 meter), patient database record, location information based on GPS, multimedia services
2008	No explanation
2009	Recording & reporting (R&R), Tele-reporting, Tele-coordination, Tele-consultation, Patient registration,

	Medical notes, Paperless prescription, For disaster relief, promotion of health services, Tuberculosis management, safe motherhood program
2010	Tele-consultation, Outbreak management, Electronic prescription, Tuberculosis management, e-psychology
2011	e-prescription, Disease diagnosis, patient and drug data record
2013	Diagnose Heart and lung disease based on frequency of the sound of breath
2014	Patient mental health consultation

Based on the review of fourteen papers, there were found explanation related to the information exchange media, the implemented technology and available features in e-health application in Indonesia. Some papers did not explain the information exchange media and detailed features of the e-health application, yet the explanation on the technology that was implemented in the e-health application can be found in each of the paper.

There were some information exchange media that were used in the e-health application in Indonesia from 1985 to 2014 as illustrated in Figure 3. Out of the fourteen papers that have been reviewed, the media employed for information exchange have been found including teleconference, text, image transmission, video streaming, television conference, radio packet communication systems, email, videophone, short messaging systems, telephone, fax, online chat, and audio streaming in various usage frequency in 1985 to 2014. The most frequently used information exchange media in 1985 to 2014 were video streaming, email and short messaging system in which those three media were used four times in 1985 to 2014 which showed that internet had a significant role in facilitating the video streaming and email. The use of SMS (short messaging systems) was also implemented in e-health application to facilitate information exchange that did not require internet connection.

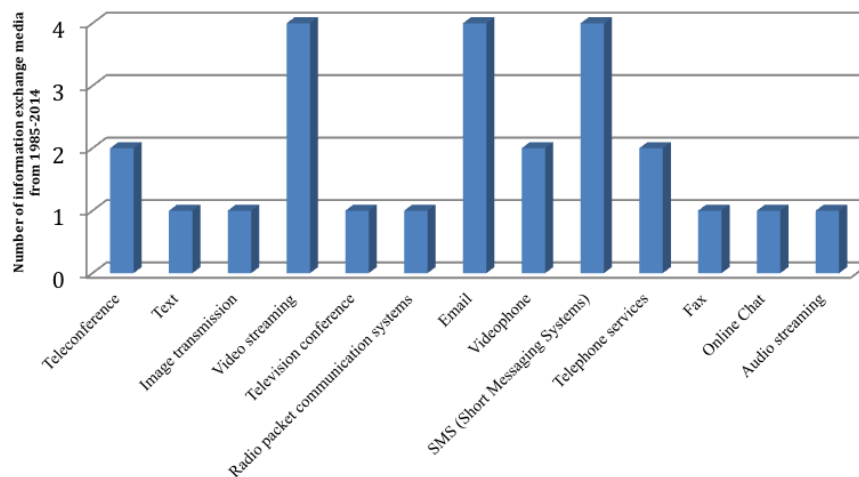


Figure 3. The number of information exchange media from 1985-2014

Number of information exchange media types that were used in e-health application in 1985-2014 can be seen in Figure 4. The figure shows the number of the use of information exchange media type in 2010 and the four types of frequently used information exchange media in that year. The second place of the highest number of the use of information exchange media types was in 2004, 2008 and 2011 in which three types of media were frequently used in those years. Generally, the number of the use of information exchange media types in e-health application kept increasing in each year until 2010. However, in 2014, the number of the use of information exchange media types decreased which happened due to the e-health application that was designed in that year did not require various information exchange media types, instead it used only two or three kinds of media for information exchange related to health.

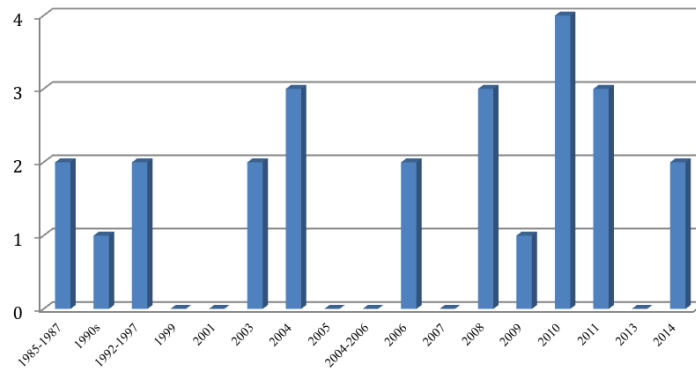


Figure 4. Number of information exchange media types on e-health per year

The various technology that was employed in e-health application in Indonesia in 1985 to 2014 can be seen in Table 3. The number of the technology that was used in e-health application was varied from year to year such as presented in Figure 5. The highest number of the use of technology in the application was found in 2010 where eight different types of technology were employed in that year. However, in the following years, this number decreased. In 2014, there were only two types of information exchange media employed in the application which were the internet network technology and telephone line technology.

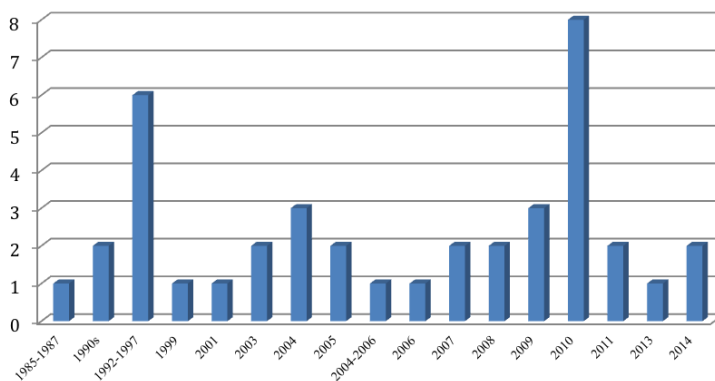


Figure 5. Number of technology used on e-health per year

It was found that there were various features used in e-health application in Indonesia from 1985 to 2014 which was varied in each year as presented in Table 4. Not all of the articles had explanation on the use of e-health features such as the ones in 1985 to 1987, 1990s, 2001, 2003 and 2008. Based on the reviewed papers on the number of frequently used e-health features, the highest number was found in 2009. Yet, as the technology developed, this number decreased in 2009 to 2004 as illustrated in Figure 6.

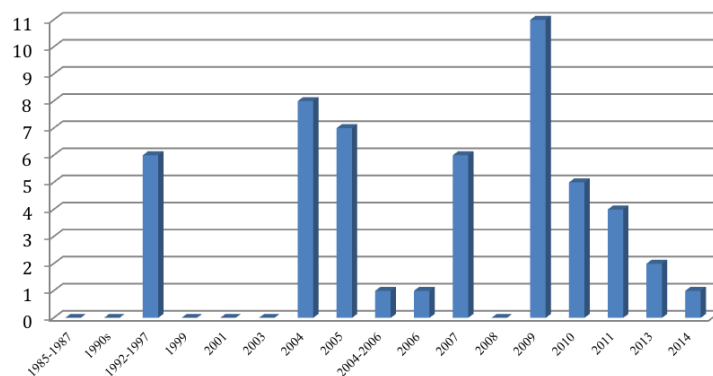


Figure 6. Number of feature on e-health per year

4. DISCUSSION

First telemedicine experiment with computer and satellite was conducted in 1985-1987. This application used teleconference and text for information exchange. In this period, picture transmission had not yet been understood until in 1990 when the experiment of image processing and picture transmission was performed with narrowband technique. In 1992-1997, e-health application was developed with ETS-V L-Band transmission. This application employed the power of 64 Kbps to facilitate video-streaming-based learning among the members of PARTNERS (Pan Asia-Pacific Region Telecommunication Network for Experiments and Research by Satellite). This application was then properly used for education and medical communication. In 1997, satellite-based telemedicine experiment was carried out by three institutions, respectively, Faculty of Health and Faculty of Engineering in UNJANI Bandung as the central stations, and Mataram Central Hospital and Harapan Kita Jakarta Hospital as the clients. The demonstration was carried out at maternal health service using three television-conferences that were fully dedicated to the usage in eastern parts of Indonesia often less accessible. Other experiment was wireless-based telemedicine system experiment that connected two health schools in Bandung, precisely Hasan Sadikin Hospital (RSHS) and UNJANI. The connection involves Wireless LAN 2.4 GHz linked to Satellite JCSAT 3. This connection had been trialed between ITB and CRL in Tokyo and it used ISDN to connect the system to Ohkura National Hospital in Hibiya, Tokyo [9]. At the same year when a telemedicine module was made, the focus of telemedicine module was concentrated upon the distribution of service (quantity) rather than the completion of service. The development of hardware and software combination for telemedicine module was made based on criteria and procedures of teledata application. Three systems were internalized into telemedicine module for startup function. The first system was the monitoring of fetus heartbeat using PC-based USG to detect and to analyze fetus heartbeat. This system involved ultrasonic transducer, hardware interface and software, all designed to analyze fetus heartbeat. The beat was presented on monitor or materialized as the printout. The second system was PC-based Tension-meter that consisted of sphygmomanometer module, hardware interface and software. This system was targeted to pregnant mothers because they must undergo periodic checking for their blood tension, especially in their third semester of pregnancy. The third system was PC-based Electronic Weight. It comprised hardware to measure body weight, PC interface, and software that were all customized for analysis and evaluation of nutrient assessment status. The result of reading would be shown on the monitor and be printed on paper [10]. In 1999, a study about image coding as well as information search and information exchange was carried out, and the research article about image coding of neuro-VQ X-ray system had been presented before IEEE-ISPACS [9].

Indonesia is the member of Asia Pacific Association for Medical Informatics (APAMI); yet, the status of its health informatics is still lower compared to other members in terms of national policy and awareness level to health informatics. Indonesia has not yet taught health informatics in universities until 1999 when Indonesia learned medical website [11]. In 2001, Indonesia used telecommunication satellite to communicate matters of medical treatment across the islands [12]. In 2003, the low-speed communication system was developed to access the internet using internet radio packet and using PostgreSQL database when Linux machine was provided. This development was pursuant to the consideration of database management system called as Automatic Distributed Synchronizing Database System. This system related one health center to another and avoided the storage of central data as usually used until now. The communication through radio packet with radio instrument would not need connection cost as found in the use of telephone for data communication. General physician in remote and isolate area could ask for help from the specialist doctor in town only through email. In an experiment, the author used three health centers by assuming that each was located at smallest island in distant to each other, and each station had its database and the entire database. Each station could present, input, edit and delete the data in the database and present the entire database.

If one station damaged, the system still had the whole database covering all data of all stations. Database mechanism had been programmed using Crontab Program on each PC. Crontab Program underwent some or multiple shell scripts which then operated the database. The connection with radio packet was made by using a hand-held transceiver, sound card and ptt circuit. In this arrangement, the table was divided based on type of information data. Radio packet could be used as the particular digital mode in amateur radio communication and could be redefined for computer telecommunication. AX.25 (Amateur X.25) was used as the communication protocol for radio packet. Such arrangement avoided the general centralized storage because the centralized storage had fatal weakness in that if the centralized storage damaged, all database systems would be in danger. Radio packet communication system utilized HF or VHF waves and thus did not need connection cost as in the case of telephone connection for data communication. It was a high achievement for the developing country. Health Center in urban area was connected to internet equipped with telephone cable and dial-up connection. In this experiment, the difficulty arose in browsing www using 1200 bps radio packet, but it still facilitated the communication of email and text about patient data. General

physicians in remote area may easily access to the assist of specialists in town. It seemed becoming new phenomenon or epidemic to find SARS using email. Lower price, easily usage and sustainable patient information network were the advantages owned by primary health care in Indonesia [13]. It opened people's view about data storage in the future, along with its distribution, synchronization, maintenance and security.

In 2004, Coding CS-Wavelet was still working. Telemedicine was developed with the focus given to Community Health Center in Indonesia. The author developed internet-based telemedicine system. It accommodated some applications such as teleconsultation, telediagnose, simple telecoordination, tele-education and drug database. In the same year, Research Group of Faculty of Health of Padjajaran University had developed a telebiomicroscopy. In this system, a microscopic description of eye disease was transmitted through wireless communication channel. Based on the result, it was concluded that eye disease diagnose could be done remotely using telemedicine system. This experiment was performed in hemodynamic status, through which disease data of critical patient was transmitted with communication channel. Hemodynamic could work with the assist of cardiovascular performance when it supplied oxygen to peripheral tissue to maintain metabolism. The experimental result was promising. PT Telkom (Indonesia national telecommunication company) had developed web-based medical information system for general communities. This system was integrated with medical information database and information transmission system using Wireless Access Protocol (WAP). In other case, MediFa had used videophone to connect the primary treatment clinic with the referral hospital. Videophone system facilitated teleconsultation and tele-education. Then, this system had been extended to use new technologies such as video streaming, SMS (Short Messaging Systems) and WAP, which could also be used by physician family [9].

In 2005, a specific ICT-based e-health system is designed for epidemic management, and it aims at giving support to the reporting stations (CHC (Community Health Center), or Puskesmas) and the monitoring station (Health Office, Urban Health Official) with trustable and user-friendly epidemic management system. Several e-health prototypes are developed for web-based epidemic management system and also for mobile-phone-based system in multi-communication links. Basically, mobile telecommunication system comprises basic units (installed at the Hospital or health service unit) and mobile/movable units (installed into the ambulance or the moving vehicle). This system has been designed to choose the communication link existed at certain location of mobile (or movable) units. This system can also measure and transfer various medical information such as ECG signal, blood tension, temperature, and SpO₂ from mobile (movable) unit to base unit. In 2005, Wireless LAN (Local Area Network) was used to support the transfer of the needed medical information [14]. In 2006, Surgery Operation used teleconference that utilized DVTS (Digital Video Transport System) [15]. DVTS is a software application used to send and to receive digital video streaming through the internet.

In 2007, mobile telemedicine was designed under tele-emergency project to provide medical health care service at remote area. This systemic design used mobile internet protocol at version 6 (MIPv6) combined with fast network based on Mobile Ad-hoc Network (MANET) and Wireless LAN (WLAN) technology of IEEE 802.11. The prototype of mobile telemedicine system, including hardware and software, can be deployed quicker into remote area or at disaster site where telecommunication infrastructure breaks down. Tele-emergency must work at remote area with the limited communication infrastructure, must perform well at emergency condition and situation, can manage patient's medical record electronically, will support multimedia communication and geographic information system at real time, and can operate at lower operational cost. Base service given at tele-emergency system includes digital electrocardiogram (ECG), oxymeter (spo₂ meter), patient database note, and location information based on GPS technology. These services are extended to consider more comprehensive multimedia services. All these services can be provided at rural area using wireless communication although the hospital only has communication cable [16]. In 2008, telecentre concept was activated throughout Indonesia regions [17]. Telecentre is the people's facility by which the people can interact, work and play by using computer, the internet and various technologies of information and communication. Mostly, small size telecentre has provided simple telephone services covering email, internet, fax, photocopy, printing and telecommunication.

In 2009, ADSL internet access was used at community health centers, and, later on, telemedicine and e-health system were also developed. Indeed, e-health development is also aimed for recording and reporting (R&R) services such as health administration (support), health status evaluation, R&R without/with telereporting, telecoordination, and teleconsultation (limited). This year also witnesses the design of e-health system with the ability to give paperless prescriptions, especially at level of community health center (CHC). The development of web-based software package has several main functions such as recording/recapitalizing patient data (patient registration), preparing medical notes (during medical checking phase) and giving paperless prescriptions for the case of alert or ADE (Adverse Drug Events). In such case, the prescribed medicines are prepared, then patient data and medical regulation report are administered, and the real report is sent to District Health Office. By using e-health system with the ability of paperless prescription, it is

expected that this system can increase health service efficiency, reduce process time, and provide better service in the future. The author distinguishes e-health system configuration into three scales, namely, minimum, medium and full. At minimum scale, e-health system configuration comprises one PC and one proper software package. At medium scale, e-health system configuration consists of two or three PCs with one proper software package and simple network. And at full scale, e-health system configuration contains at least 6 PCs with compatible software package (installed into PC Server) and hub network. Various applications are provided within mobile e-health system, such as Mobile Telemedicine for disaster relief, health service promotion using SMS (Short Messaging Service), SMS-based reminder at e-health system in Tuberculosis Management, and e-health system for maternal safety program [14].

In 2010, telemedicine and e-health were introduced as the part of biomedical technique which involved various disciplines and simple block diagram. The development of telemedicine and e-health is arranged in such way that a medical station can connect to the terminal at real-time for teleconsultation between general physicians and specialists, and facilitate the operation of store-and-forward for the distribution of short report about the recapitalization of patients at community health center. Various examples of telemedicine and e-health systems with various applications are described as follows: (1) Community Health Center (CHC) Telemedicine System may involve various PCs used as "terminals" (medical stations) PC, specific software compatible with system function, and the connection with local network (LAN) or global network (internet network). A community health center may have e-health system comprising of only one medical station. A system of Telemedicine/e-health can involve some medical stations; (2) Telemedicine System for Epidemic Management can be based on the web (internet), cellular phone network, and combination of both. The system may involve a monitoring station (computer with software, application and database), some reporting stations, and telecommunication network (internet network and cellular phone network); (3) Electronic Prescription System may involve only one local PC or a system of some local PCs connected into the local network (usually local area network, LAN); (4) E-health System for TBC Disease Management is arranged from several components such as hardware system (can be one PC or some PCs in a local network) or a modem or cellular phone connected to PC. Short message service (SMS) can be sent to one or some patients based on the predetermined schedule; (5) Mobile Telemedicine System with Multi-Communication Links comprises two parts such as base unit (installed in a hospital) and the mobile unit (installed in the mobile ambulance or mobile CHC). Arbiter module allows telemedicine system to choose the cellular network with the best characteristic for certain moment; (6) e-Psychology, a system that uses e-mail, Yahoo Messenger, and Skype; (7) m-Health (Mobile e-health) System, that uses cellular phone network; (8) E-Health System based on image processing. Finally, (9) Open HER & Open MRS System chooses certain modules and arranges them into open source "software package" [18].

In 2011, e-health is developed using multimedia messaging service (MMS) technology for the streamed audio and video files at mobile environment, and aimed for disease diagnose [19]. In similar year, e-prescription system equipped with mobile e-health system for child and maternal treatment is also developed to support the administration of patient and medicine data. This system comprises SMS (Short Messaging System) module that can send short message at different operation modes. Basically, e-prescription for mobile e-health is PC-based e-health system with an additional SMS (short messaging system) software module and an adhering modem. SMS software module can perform the management of transmission and receipt of various types of SMS based on application demand. Software module is built using some elements of open-source software such as Apache web server, MySQL server database, and Gammu SMS engine [20].

In 2013, e-health application was made to diagnose heart and lung diseases based on the principle of separating breath voice frequencies using modulation filtering method. This method could distinguish voices of lung and heart based on breath voice frequency [21]. In 2014, email and telephone were used for communicating medical information about mental health of patients in Aceh Province [22].

5. CONCLUSION

Based on a number of studies, we find that e-Health in Indonesia has been applied since 1985. The technologies and features used from time to time were growing in some period of time. However, the study also shows that from that point of time the number and variety of technologies and features provided are decreasing, and the focus has shifted to further analysis of the problems needed to be solved and provision of technologies and features only relevant to those problems. The development of e-Health applications in Indonesia has given promising results in providing health services, but they are still conducted by certain educational institutions and their uses are not evenly distributed throughout Indonesia. e-Health policy in Indonesia remains unclear. Considering the problems of the policy regarding e-Health in Indonesia, in the

future we will conduct a research on this policy because it is believed that this is one of the main causes that make the use of e-Health in Indonesia non-optimal.

ACKNOWLEDGEMENTS

The authors wish to thank the members of the Information System Research Group and Master students of Computer Science at Brawijaya University, Indonesia, for supporting this study.

REFERENCES

- [1] Indonesia.go.id. Portal Nasional RI - Geografi Indonesia [Online]. [cited 20 May 2015]. Available from: <http://indonesia.go.id/in/sekilas-indonesia/geografi-indonesia>
- [2] Media K. Pulau Terpencil Minim Akses Kesehatan - Kompas.com [Online]. KOMPAS.com. 2011 [cited 20 May 2015]. Available from: <http://megapolitan.kompas.com/read/2011/06/30/10315845/pulau.terpencil.minim.akses.kesehatan>
- [3] Sudaryanto A. and Purwanti O., "Telehealth dalam Pelayanan Keperawatan", *Seminar Nasional Informatika 2008 (semnasIF 2008)*, 2008, pp. 7-10.
- [4] Kristianto E., "E-Health di Indonesia", *Jurnal Teknik dan Ilmu Komputer*, vol. 2, pp. 167-171, June 2013.
- [5] Brownsell S, *et al.*, "An evaluation of second and third generation telecare services in older people's housing", *J telemed telecare*, vol. 14, pp. 8-12, 2008.
- [6] H. Takeda. E-health. Berlin, Germany: Springer; 2010.
- [7] Chung Y., *et al.*, "Medicare-Grid: New Trends on the Development of E-Health System Based on Grid Technology", *IFIP - The International Federation for Information Processing*, Brisbane: Springer, pp. 148-159, 2016.
- [8] Harmse R. and Pottas D., "Help Me to Understand Your World: A Reflection on the Potential Impact of E-Health Systems on the Prognosis for Asperger Syndrome", *IFIP - The International Federation for Information Processing*, Brisbane: Springer, pp. 201-221, 2016.
- [9] Suksmono A., *et al.*, "Overview of Telemedicine Activities in Indonesia: Progress and Constraints", *IEEE*, pp. 37-40, 2004.
- [10] Irawan Y. and Soegijoko S., "Development of Appropriate Telemedicine to Improve the Management Information System for Community Health Care in Indonesia", *19th International Conference*. Chicago: IEEE, 1997, pp. 991-994.
- [11] Lun K., "Health informatics in the Asia Pacific region", *International Journal of Medical Informatics*, vol. 55, pp. 3-7, 1999.
- [12] Nakajima I., *et al.*, "The final report of the project 'AMINE' The Asia Pacific Medical Information Network using with ETS-V", *International Journal of Medical Informatics*, vol. 61, pp. 87-96, 2001.
- [13] Pambudi I., *et al.*, "Sustainable Patient Information Network (SPaIN) for Primary Care Health Center in Indonesia", *25th Annual International Conference of the IEEE EMBS*. Cancun: IEEE, 2003, pp. 1421-1424.
- [14] Soegijoko S., "ICT Applications in e-Health: Improving Community Healthcare Services Towards Achieving the Mugs", *The United Nations Conference Centre*. Bangkok, 2009.
- [15] Shimizu S., *et al.*, "Technologic developments in telemedicine: State-of-the-art academic interactions", *Surgery*, vol. 147, pp. 597-601, 2010.
- [16] Husni E., *et al.*, "Combined Mobile Ad Hoc Network and Mobile IP for Mobile Telemedicine System", *Jurnal Teknik Gelagar*, vol 18, pp. 25-32, 2007.
- [17] Lucas H., "Information and communications technology for future health systems in developing countries", *Social Science & Medicine*, vol. 66, pp. 2122-2132, 2008.
- [18] Soegijoko S., "Perkembangan Terkini Telemedika dan E-Health Serta Prospek Aplikasinya", *Seminar Nasional Aplikasi Teknologi Informasi 2010 (SNATI 2010)*, Yogyakarta: Teknik Informatika, Fakultas Teknologi Industri, Universitas Islam Indonesia (TI FTI UII), 2010, pp. 1-8.
- [19] Setyono A., *et al.*, "Development of Streaming Application for Mobile Telemedicine System Using Multimedia Messaging Service Technology", *IEEE*, pp. 574-578, 2011.
- [20] Soegijoko S., *et al.*, "e-Health for Improving Community Healthcare: Encouraging Clinical Experience of Simple e-Prescription System and m-Health System Development for Mother and Childcare", *2011 IEEE 13th International Conference on e-Health Networking, Applications and Services*, IEEE, 2011, pp.102-105.
- [21] Mardiyanto M., *et al.*, "Study of Lung and Heart Diagnosis Application based on Frequency Separation of Breath Sound", *Procedia Technology*, vol. 11, pp. 1122-1126, 2013.
- [22] Grayman J., "Rapid response: Email, immediacy, and medical humanitarianism in Aceh, Indonesia", *Social Science & Medicine*, vol. 120, pp.334-343, 2014.
- [23] Shivaputra, Sheshadri, HS., Lokesha, V., "A Naïve Visual Cryptographic Algorithm for the Transfer of Compressed Medical Images", *Bulletin of Electrical Engineering and Informatics*, vol 5, pp. 347-365, 2016.
- [24] Satria, M.H., *et al.*, "802.11s QoS Routing for Telemedicine Service", *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 4, pp. 265-277, 2014.
- [25] Wang, L. and Alexander C.A., "Telemedicine Based on Mobile Devices and Mobile Cloud Computing", *International Journal of Cloud Computing and Services Science (IJ-CLOSER)*, vol. 3, 2014.
- [26] Brocke, J. V., *et al.*, "Reconstructing The Giant: on The Importance of Rigour in Documenting The Literature Search Process", *European Conference on Information Systems*, pp. 2206-2217, 2009.