

OPTIMIZATION OF HOSPITAL PATIENT MANAGEMENT IN HOSPITALS WITH ANDROID-BASED APPLICATIONS

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ABSTRACT. *Android operating system is currently widely used, because it is open source, making it easy to learn and develop. Nevertheless, there are still some fields that have the potential to develop with the help of smartphones but have not been maximized, one of which is the health sector. The increasing use of smartphones also makes WHO begin to pay attention to the use of mobile devices for the health sector or known as mHealth. However, based on a WHO survey, the use of mHealth in the South-East Asia Region is the lowest even though in that region there are India and Indonesia which are two of the top ten smartphone users worldwide. The purpose of this research is to develop and design an Android-based mobile application for inpatient management within the hospital which is also equipped with a website for administrators. The application aims to reduce manual recording of inpatient data so that data is more easily accessed when needed and becomes a means of communication between doctors and nurses.*

Keywords: Application, Management, Inpatient, Android

1. Introduction. Smartphones are already part of human life in the modern area. Smartphones with features and mobile applications have had an effect in the areas of business, education, and social life [1]. These conveniences have caused the number of smartphone users in the world to increase. Indonesia itself is among the top 10 smartphone users in the world with more than 67 million users [2]. Based on statistical data from StatCounter (2018), the smartphone market in the world is dominated by the Android and IOS operating system. Android controls the market with a share percentage reaching 75%, while iOS on second place with 19%. In Indonesia, Android operating system is far dominant with a share of 90.63%. Countries such as India and Indonesia are the main key drivers of Android's growth because it continues to experience a very significant growth in the number of users [3]. While other countries that were previously dominated by iOS like United States, also experienced an increase from the number of users of Android operating system. Nevertheless, there are still a few fields that have the potential to develop with the help of smartphones but have not been maximized yet, one of which is the health sector. The World Health Organization (WHO) has made e-Health one of the priorities of the organization since 2005 [4]. The increasing use of smartphones has also made WHO begin to pay attention to the use of mobile devices for the health sector or known as mHealth. However, based on WHO survey, the use of mHealth in the South-East Asia region is the lowest even though in the region there are India and Indonesia which are two of the top ten smartphone users worldwide.

In Indonesia, e-Health, or more specifically mHealth, still has not benefited much from the development of smartphones. The development of e-Health in Indonesia is still fixed

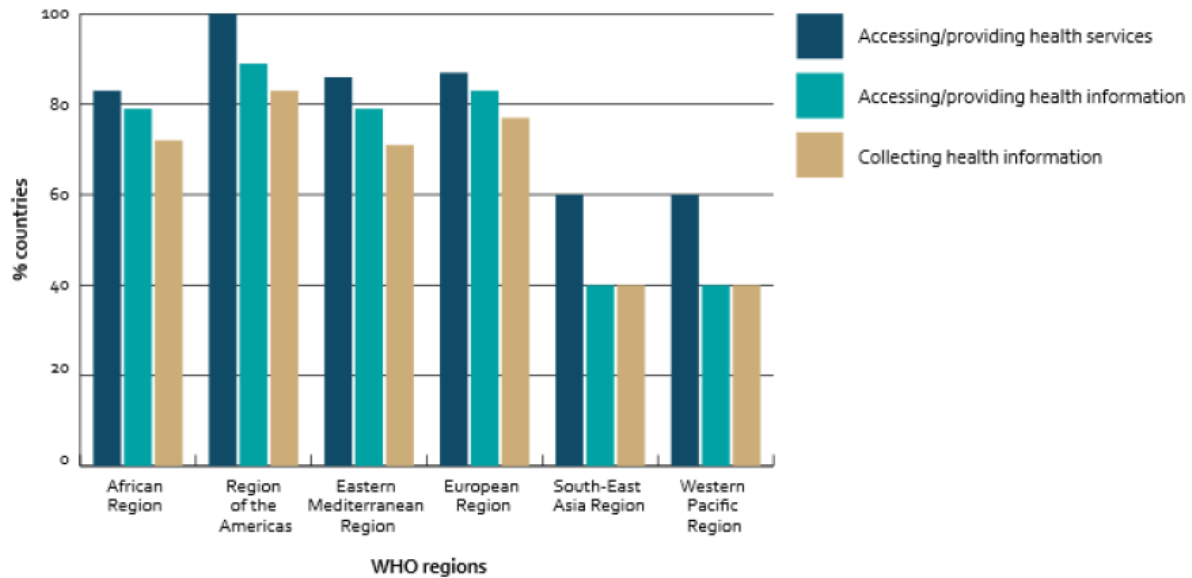


FIGURE 1. Percentage of countries that have the type of mHealth program based on the WHO region

on certain institutions and not spread evenly according to a study conducted by [5]. In addition, the study also mentions the absence of government policy regarding e-Health has an impact on the development of e-Health. At present, mobile applications for the health sector are still dominated by consultation applications with doctors. While for hospital, it is still difficult to get benefit from the development of e-Health because many hospitals do not yet have adequate information systems.

From the 2,734 hospitals in Indonesia in 2016, there were only less than 1,500 hospitals that already had an active information system [6]. This causes data management to be less than optimal because it still uses manual recording even though this can slow down the patient's care process when it requires access to patient data at other times. The information system in the hospitals is still constrained by a few factors such as equipment prices, lack of knowledge and lack of experts in information technology regarding hospital management [7]. While hospitals have implemented information systems in hospital, other problems that they faced are short infrastructure lifespan, minimal infrastructure maintenance budget, the high burden of recording in information system [8].

Based on problems that have been mentioned, it is necessary to optimize patient information system in the hospital that still uses manual recording. The author sees that the patient information system can be optimized by using an Android-based mobile application. The use of mobile applications for inpatient management can reduce the cost of IT infrastructure for hospital information systems and facilitate data access compared to manual search. There are two applications to be developed, one for nurse or head nurse and one application for doctors. It also added a web application for administrators. The application uses the REST architecture as a web service to communicate between client and server. To support the application, a web application for administrators with framework7 will be created.

2. Literature Review.

2.1. State of the art. The health service sector has several heterogeneous related systems for integrating medical equipment. All these systems must run smoothly in response to request for information from users and the presentation and collecting information must make it easier for medical personnel to carry out their activities. As for making a mobile

health software there are several challenges such as complex medical information, language difference, to the type of hardware used. To overcome these problems, a special agency called Agency for the Integration, Diffusion, and Archive (AIDA) was formed to help the integration of health information in hospitals using a framework. AIDA will act as a core in the electronic medical record system, diagnostic and treatment procedures, information systems for monitoring, to work arrangements. It also created an Android-based mobile application that can access data through web services and then to the database via intranet at the hospital. The application will use the SOAP (Simple Object Access Protocol) protocol to exchange information in the form of XML. In the result of the analysis after implementation in a hospital in Portugal, this application is said to have a number of advantages but there is still weakness which is the dependence of intranet connections and some features that slow down the application [9].

[10] conducted research and designed an Android-based mobile application that is capable of displaying some physiological parameter information such as electrocardiograph (ECG), electroencephalograph (EEG), respiratory rate, blood pressure, body temperature, level oxygen in the blood. This application is designed with the aim of increasing the comfort of patients who have to use a monitor for a long time, so it is not limited to certain areas. To monitor the patient's physiological condition wirelessly, a 3AHCare node is used as a module to obtain physiological parameters. The 3AHCare device is formed into a vest that the patient will wear to monitor his condition. In its application, the mobile application acts to display information and sends to the server the data obtained from the special 3AHCare device. The connection from the 3AHCare device to the Android application uses the help of Bluetooth, while for sending data to the server an Internet connection is used. As a result, these devices and applications can allow monitoring of patient conditions without being hindered by a relatively low cost.

[11] tested a decision-making mobile application to help prescribe antibiotics at a university hospital in Brazil (although the application can be downloaded publicly). The use of antibiotics in addition to having to meet medical requirements also sometimes consider the price for hospitals in developing countries. The mobile application is intended to optimize the use of antibiotics that are appropriate but in accordance with the reality in place. The mobile application consists of a guide to the choice of antibiotics according to the infection being encountered, besides the application is also connected to the laboratory results to provide real-time updates. Previously the hospital staff were notified of the existence of this application and as a result the hospital could save significantly the cost of antibiotic procurement. The results showed that as many as 1,741 downloads were made in a one-year period (62% using iOS and 38% using Android). This application is also made easy, because 50% usage time is less than 1 minute. In terms of the antibiotics used, it was noted that alternative antibiotics had increased use, and the cost of procuring antibiotics could be saved as much as USD 296,485.90. It can be concluded that doctors follow the application's recommendations and reduce the consumption of expensive antibiotics.

2.2. Current working system. Based on observations in the hospital, new patient data will be notified by the administrator to the doctor and the head nurse. After that the doctor will take the necessary actions and/or order the nurse about what actions need to be taken on an inpatient. The nurse performs the action requested by the doctor and records the action with relevant results in the report. Then the report is forwarded to the head nurse who will check it before sending it to the administrator to save patient care data into the system when the action for a time has been completed.

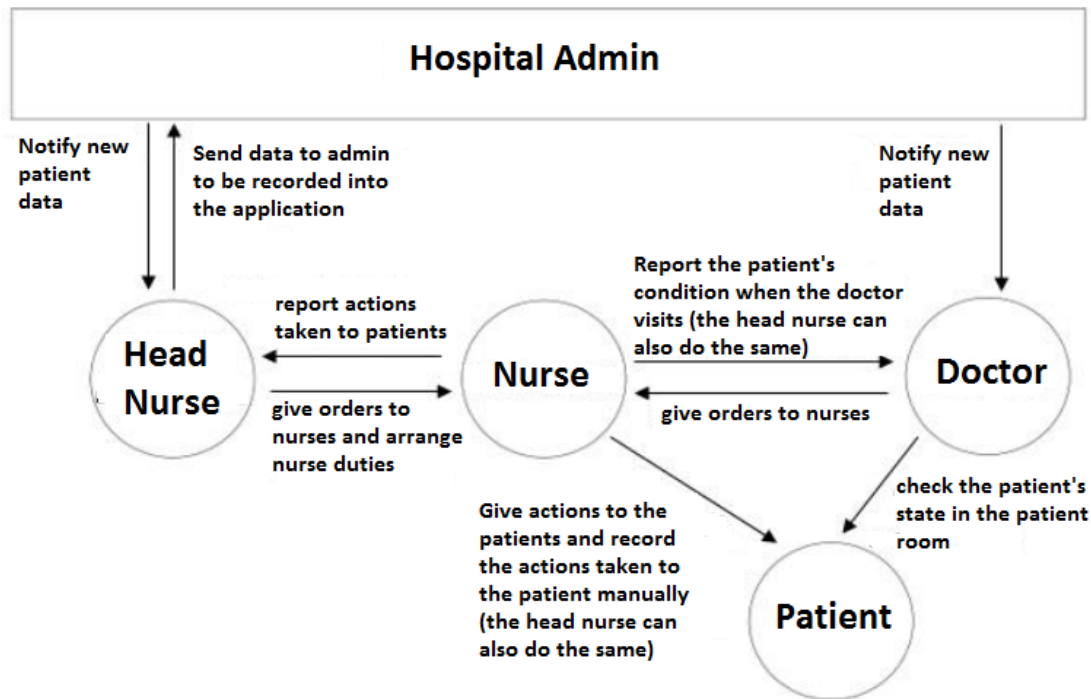


FIGURE 2. Current working system

3. Research Method.

3.1. Methodology. The development starts with literature study and seeks more complete information about hospitalization. Activities undertaken include the daily activities of doctors and nurses, inpatient management, and information technology used in hospitals. After the information collected has been obtained, a user story is formed based on the results obtained. Then each user story will be grouped into several iterations and

TABLE 1. Nurse user stories

No.	As a Nurse, I want...	So that...
1.	Can see information from selected patients.	I can monitor the progress of the inpatients.
2.	Can remind if there are patients who have not been treated.	I do not forget the activities that must be carried out on patients who are my responsibility.
3.	Can easily see the prescriptions needed by inpatients.	I do not need to confirm back to the doctor about the medication that needs to be given to the patient.
4.	Can find out what actions have been done to the patient.	I do not need to report back to the head nurse about the actions that I have taken.
5.	Can notify the doctor about the symptoms or activities experienced by inpatients.	I do not need to contact the doctor continuously.
6.	Can more easily identify patients.	I do not need to ask or repeat certain questions to patients.
7.	(Head Nurse) Can find out what actions have been taken by nurses to patients.	I do not need to ask every nurse to report what has been done to the patient and ask the condition of each patient to the nurse on duty.
8.	(Head Nurse) Can arrange the duties of nurses and monitor patients who have not been handled.	I do not need to evaluate individual patients who have not been treated manually.

TABLE 2. Doctor user stories

No.	As a Doctor, I want...	So that...
1.	Can ask nurses to take special actions against patients through the application.	I do not need to contact the nurse continuously.
2.	Can write prescriptions for patients periodically through the application.	I do not need to tell the nurse continuously about new recipes that I have made.
3.	Can see information from selected patients.	I can monitor the progress of inpatients.

TABLE 3. Admin user stories

No.	As a Admin, I want...	So that...
1.	Can take care of patient discharges easily.	I do not need to take care of the patient files that I want to send home.

included in the development schedule to determine the estimated time needed for making iterations. The design phase is carried out by designing the system according to the needs by medical personnel.

3.2. **Architecture.** The application is designed using cloud hosting from Gearhost as a server, where on the client side (Android and browser) make HTTP requests to the server using get/post method. The choice of method is depending on the type of request required. If the data is not too confidential, then GET request will be sent. After the request has been received on the server, web service call using PHP to run a query on the SQL Server database, after that the results of the query will be processed on the server and the server will send data back to the client side in JSON form. The type of data returned to the client side is the data that sent along with the code to tell whether the requested request is appropriate.

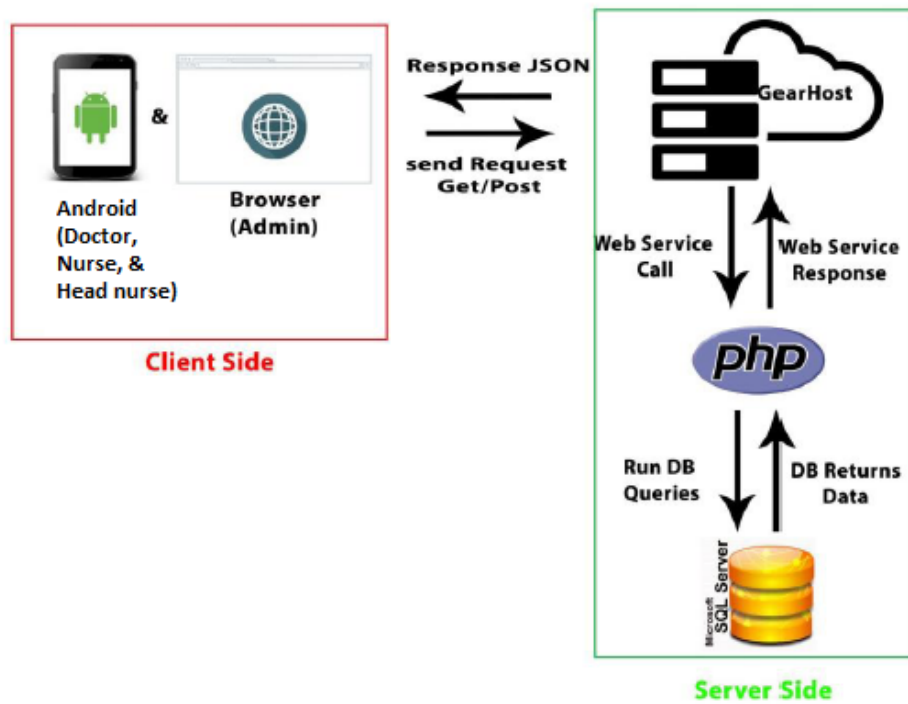


FIGURE 3. Application architecture

4. **Result and Evaluation.** From the evaluation that has been carried out it can be concluded that the use of the application can reduce the number of steps that must be carried out in caring for inpatients in a hospital. With the use of this application, the head nurse does not need to report back the actions that have been taken to patients to the hospital administration, because every action that has been done will be automatically saved into a database and can be seen directly by doctors and nurses.

Nurses also do not need to report the patient's condition regularly to the doctor. The application also helps head nurses and doctors to manage the duties of nurses and monitor patients easily. The notification feature that will remind doctors and nurses of their duties also makes it easier to monitor. In addition, the use of this application also helps reduce paper usage when taking care of inpatients because every action taken is recorded using the application and stored in a database.

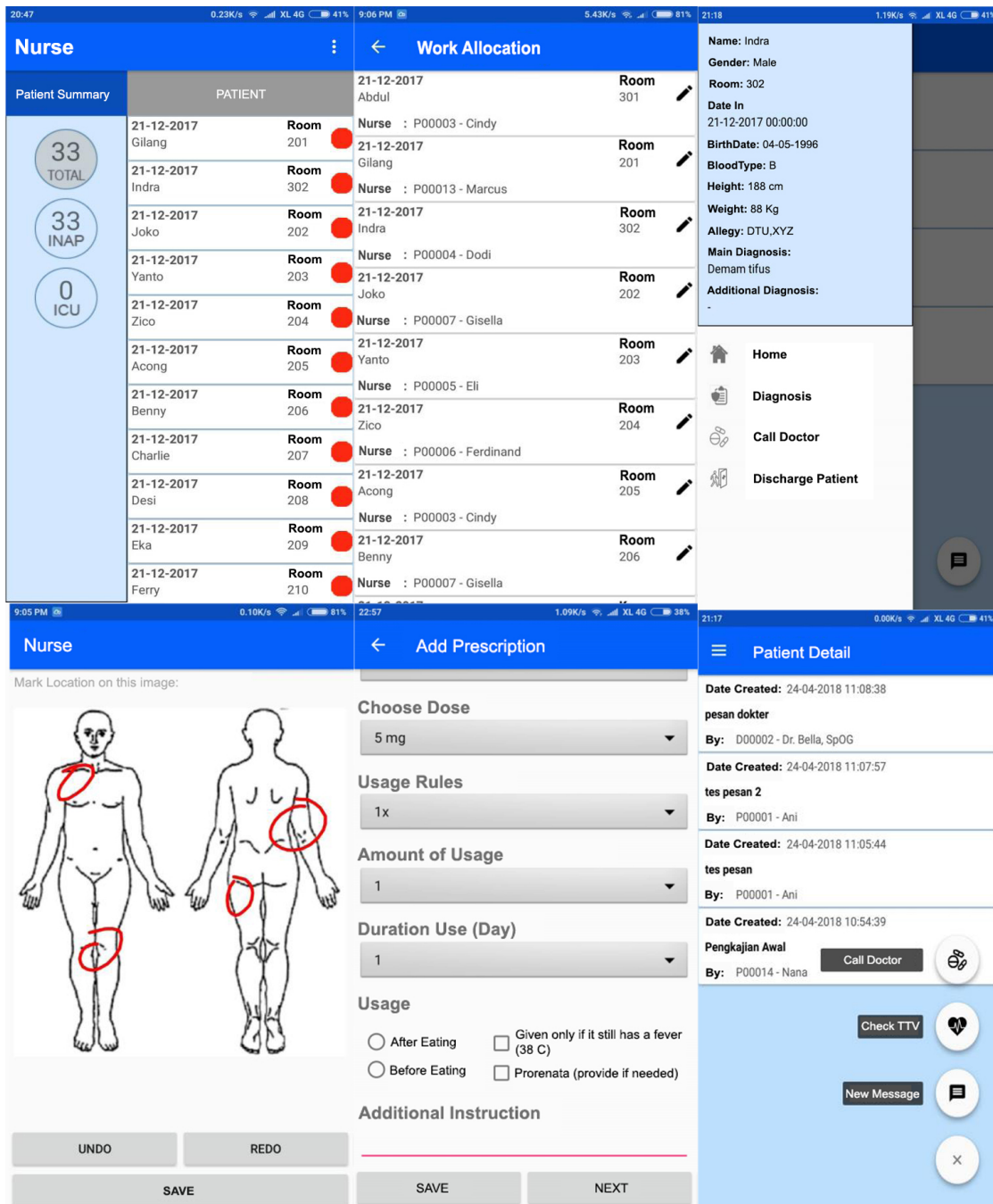


FIGURE 4. Screenshot of doctor, nurse, and head nurse application

5. Conclusions. Android-based application for inpatient management for doctors and nurses is developed to facilitate users in accessing inpatient information when needed. The application can assist nurses in managing inpatients as well as being an effective means of communication for doctors and nurses, helping doctors in monitoring patients when the doctor is not in the hospital and arranging actions that need to be taken to patients when needed. For the future research, there are several features that can be developed such as patient nutrition regulators, recording liquid intake-output, regulating vital signs monitoring intervals, laboratory test modules (including X-ray or CT Scan results) to be integrated with patient data, developing notifications in order to alert medical personnel if there are vital signs or laboratory results that enter critical values.

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