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FinDoctor–Interactive Android Clinic Geographical Information System Using Firebase and Google Maps API

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***Abstract*—Health is a very important thing for human life. Health must be maintained for human survival. This is the main reason someone is looking for a doctor as fast and appropriate in dealing with the illness or commonly called a check-up. The number of processes that must be done by patient while seeing the doctor can make the patient feels uncomfortable. Departing from these problems, a system should facilitates the relationship between patient and doctor in a more efficient way. This research proposes a mobile Android and web application to facilitate the needs between doctors and patients. The designed application using MySQL as the main data storage like data of doctors, patients, clinics, and doctor's assistant. Firebase Storage is use for saving additional data such as doctor's files, or photos. The system also uses other Firebase service that are Firebase Real-Time Database to handle chat data and Firebase Notification to create notifications. The application also uses Google Maps API to support GIS.**

***Index Terms*—Android, GIS, Firebase, Google Maps API, Doctor, Interactive**

I. INTRODUCTION

Health is a very important thing for human life. Health must be maintained for human survival. Variation types of diseases that attack the human immune system, making prevention and treatment of the disease becomes indispensable. This is the main reason someone is looking for a doctor as fast and appropriate in dealing with the illness or commonly called a check-up.

The usual check-up process starts from determining which doctor to visit. This is done by matching the doctor's schedule with the desired time to check [1].After determining which doctor is right, the next step is to visit the doctor and take the queue number [2]. The patient waits for the examination. The doctor who finished examining the patient should then write a medical record as a record. Doctors also have to monitor the patient to know direction of disease progression. Decreased, or increased.

The number of processes that must be done by patient while seeing the doctor can make the patient feels uncomfortable. The possibilities include too many queues or maybe doctor not available while the patient has arrived at the clinic.

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The problem also arises when patient becomes confuse to seek another doctor with the required specialization as soon as possible, without knowing where the nearest clinic is located.

On the clinic side, doctor or doctor assistant often see the difficulties to find patient medical records which is written on paper. Especially if the file is already buried so long so that the previous medical record is difficult to learn.

Keeping the medical record in traditional way is also not paperless and takes up much space. In addition, doctors / assistant doctors who arrange the queue is also difficult to control the status of patients who have taken the queue number manually.

Departing from these problems, a system should facilitates the relationship between patient and doctor in a more efficient way. Considering that patient is the one who should get help as soon as possible and the doctor should act flexibly, the most suitable application base is mobile.

One of the most widely used mobile operating systems is Android. Android as one of the fastest growing mobile operating systems [3]. The use of Android OS until June 2017 shows that Android is still the OS with the most users in the world [4]. Android is superior to other competing operating systems & acts as a superior mobile operating system. Android will be a leader in mobile platform [5].

This research proposes a mobile and web application to facilitate the needs between doctors and patients. The application is divided into four panels: Doctor, Doctor Assistant, Patient, and Admin. The doctor, doctor assistant and patient use the Android base application. While the admin using a web base.

II. METHODOLOGY

A. Doctor and Patient Interaction

Interactive communication require a person to monitor and adapt to others while observing appropriate standards of etiquette [6]. Communication between doctors and patients should also be interactive and effective. The provision of general information during the consultation is positively related to patient satisfaction [7]. Effective communication between doctors and patients can have a significant impact on patient relationships, and reputation in society [8]. In terms of relationship factors, research shows that hospitality, courteous behavior, friendly conversation, attention and certainty, building partnerships, patients choose doctors as trust people and all are positively related to patient satisfaction [7]. That's why both parties need new support tools that allow it to move forward together. Doctors who cannot communicate well with patients not only miss the

opportunity to help the patient but also face the risk of prosecution [9].

B. Firebase

Firebase is a technology that allows us to make web applications with no server-side programming so that development turns out to be easier and quicker.A single Firebase node offers up to 100 connections per second in its free edition. The paid version offers hosting and custom domains for over 3000 INR [10]. Developer can give Firebase a chance to take every necessary step: verifying users, storing data, and implementing access rules [11]. Firebase stores data in NoSQL and stores data in the form of a paired key [10]. Firebase also allows developers to use Firebase Cloud Messaging feature. Main Capabilities using Firebase Cloud Messaging [12]:
1- Send notification messages or data messages.
2- Versatile message targeting.
3- Send messages from client app.
Firebase provides up to 10 Gigabytes of data transfer throughout your database with an additional 1 Gigabyte as a storage option [10].

C.Google Maps API

Google Maps offers an API to build a web [13] or mobile based application. Android as a mobile based allows developers to integrate Google Maps with apps and provides users with functions such as displaying locations on the map, showing different routes on the map, etc [14].Google map API can be used to make a data distribution mapping [19, 20].The advantages of Android is it supports real-time process of coordinate determination by using technology of GPS [15]. A Google Map API key is required to integrate maps in Android apps. Keys can be obtained by doing the following steps [14]:
1. Install and configure Google Play services
2. Add library from SDK android manager.
3. Add Google Play services to the app library.
4. Retrieving Android certificates SHA 1 fingerprint to sign the application.
5. Create a project in the Google API console.
6. Obtain the Google Maps API key.
7. Add the unique API generated to the app.

D. Queue Theory

Queues are very familiar in our daily lives. Queue theory is a branch of operations research because the results are used to make decisions about the resources needed to provide service [16]. Queues generally run with first in, first out.
Choosing and building queuing models to reflect the complexity of the actual system in a simple way to enable mathematical analysis is an art [17]. At the hospital, queue waiting times can be used to assess many factors such as recharge time, patient waiting time, patient counseling time, and staffing level. The application of queuing theory may be particularly useful in hospitals with high-volume outpatient workload and / or providing multiple service points. Usually, some patients wait patiently to serve while others are restless and intolerant of delays [18].

III. PROPOSEDSYSTEM

Based on the analysis in part I, and II then the application that can accommodate the communication needs between doctor and patient is very possible built. Applications must be able to handle processes ranging from the doctor's search process, check registration, queue number settings and notifications, easy-to-access medical records, and chats between doctors and patients. The next section describes further design of FinDoctor.

A. Software Architecture

FinDoctor is designed on Android and the Web. It has four entities that are admin, doctors, patients, and doctor assistant. Web based of FinDoctor only intended for admins. Apps with Android base are intended for patients, doctors and doctor assistants. An overview of the four entities can be seen in the following figure.

Figure 1. Software Architecture of 'FinDoctor

The cycle of application starts from the doctor who is registering the account on the application. Registration of doctor's account requires doctor's personal data file including official certificate of practice. The application admin then checks the validity of the file. If the received file is correct and complete, the admin may approve the doctor's account. Doctors who successfully create an account, can perform clinical management within application such as adding clinical location markers, clinic information, practice schedule information, even arranging the doctor assistant access that accompanying doctor. Patients who have found a doctor with the required specialization, then could take the queue number. The queuing status that runs in the clinic is updated by doctor or doctor assistant. The queue status automatically generates real-time notifications on the patient's mobile phone. The doctor who has finished examining the patient then writes a medical record and keeps it in the system. The patient's medical record can also be accessed by the patient who owns the medical record from patient's mobile phone. Patients can have a

consultation with doctor through the application. The consultation is done by chat.

B. Context Diagram

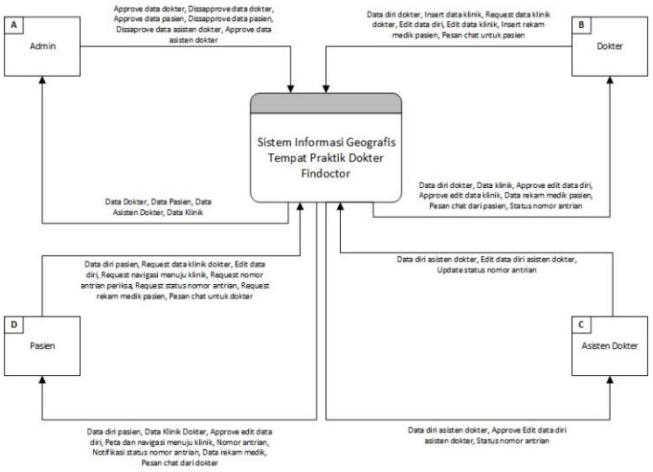

Figure 2. Context Diagram of 'FinDoctor

Figure 2 above shows the exchange data that occurs in application. Admin receives account creation request based on doctor's personal data and clinic data. Admin provided feedback for the system with approval of doctors and clinic data.

Doctor's input to the system are personal data, clinic data, medical record data including edited data, queue status data, and chat messages for patients. The flowing data from the system are doctor's personal data, patient's data, patient's medical record, queue number status, and the patient's chat message.

Patient's input to the system are personal data including edited data, medical record data requests, queue number requests, queue status requests, chat message requests, and requestnavigation to the clinic. The flowing data from system aredoctor's data, patient's data, patient's medical record, queue number status, and reply chat messages from doctors.

Doctor assistant's input to the system are personal data including edited data, and request the next queue number. The flowing data from the system is the assistant's personal data, and updated queue number according to the registered patients.

C. Database Design

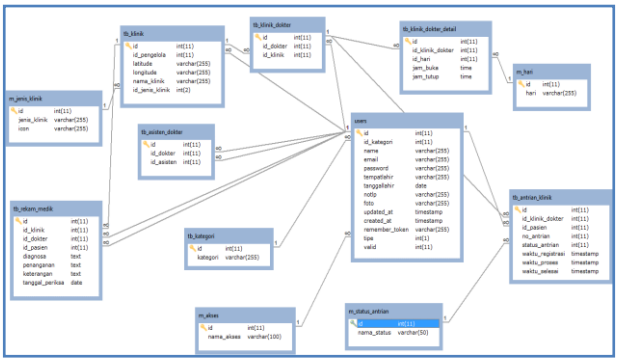

Figure 3. Database Design of 'FinDoctor

Figure 3 shows the MySQL database application design. The database consists of 12 interrelated tables. MySQL databases store data such as user data, queues, medical records, clinics, doctors, or clinic schedules. The user data and its permissions are stored in the 'users' table. The application's chat data is stored in Firebase in NoSQL. In addition, Firebase also stores doctor data files in PDF form by utilizing Firebase Storage feature. Firebase Storage utilization is done to divide the storage load.

D. Application Features

The features of the app are determined by user permissions. As explained in point 4.1 above, that application has four entities. The sharing of features in each of these entities can be seen in the following table.

Table 1. Features on FinDoctor by Entity

Admin	Doctor	Patient	Doctor Assistant
Web-based	Android-based	Android-based	Android-based
Validate doctor registration	Register the clinics	Search doctor by nearest location, or by specialist	Got patient registration privileges of from doctor
Enable / Disable doctor's account	Change the status of the clinic to open or close	See doctor information	Receive Patient Check-up Requests
	Opening or closing online consultation feature	Navigate to the selected doctor	Set the queue number
	Use online consultation feature via chat with patient	Do an online consultation with doctor	Add medical record according to doctor's need
	Input patient medical record data	Request patient check-up	
		Receive queue number	
		Receive queue number status notification	
		View self-medical records	

The application features described in table 1 above shows that the admin is the key of the application. Admin has the highest permissions can specify which account is enabled or disabled based on certain considerations.

Doctors are the users who provide clinic information and practice schedules. This information becomes the reference of the patient to further interact with the doctor. Doctors can also perform intensive interactions to monitor patients with chat consulting features. Doctors are assisted by a doctor

assistant where a doctor assistant can arrange queues and add medical records according to doctor's instructions.
Patient is the most recent application user. Patients see doctors' data to determine which clinic they want to visit.

IV. EXPERIMENT RESULT

Experiment results are divided into 3 according to the user of application. The following are the experiment results of the application.

A. Doctor

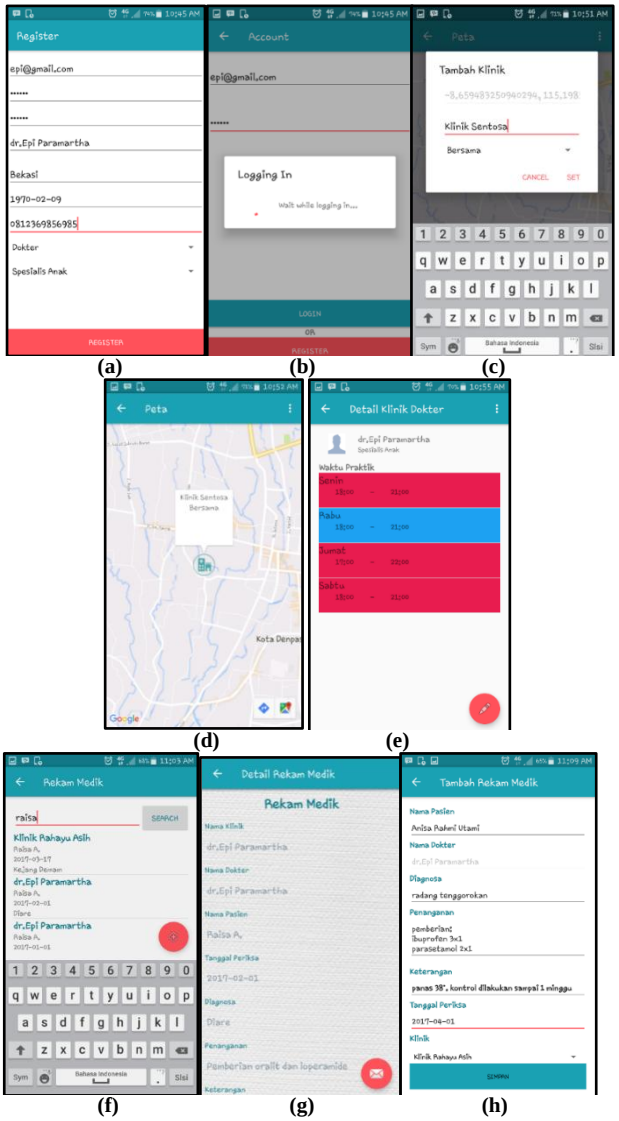

Figure 4. Doctor and Doctor Assistant Privileges

Figure 4 (a) shows the doctor registration page. Doctor registration data input include e-mail address, password, password confirmation, doctor's full name, address, date of birth, phone number, access type, and specialization.
Figure 4 (b) shows the login page. The account owner enters the e-mail address and the password of the registered account in the field provided.
Figure 4 (c) shows a clinic data pop-up window when doctors add on their clinic maps. The addition of the clinic is done by long click on the map. The added clinic is then indicated by a marker on the map in figure 4 (d). Clinic's detail schedule can be arranged and then displayed in table as information as shown in Figure 4 (e). Table with red column means not available, while blue is available.
Doctors can also conduct a patient's medical record by typing his name as shown in Figure 4(g). Medical records detail wil be displayed in the form of medical record details. Doctors who want to make changes or making a new medical record may enter data on the medical record form as in figure 4 (h).
Figure 4(f) shows the dashboard of application. The application dashboard is available with the access of doctors and doctor assistants. The dashboard displays the patient queue table for the day. The queue data consists of the patient's name, the time of queue number taking, the checking time is started and terminated, and the queue status. The 'OPEN' means that the queue of the patient has not been checked, 'ON PROGRESS' if the patient is being examined, and 'CLOSED' if the patient has already been examined.

B. Patient

Figure 5. Result on Patient Privileges

Figure 5(a) shows the doctor list page equipped with a doctor search by name feature. Patients can find the nearest clinic using the current location detection feature. This feature shows the patient's location point on the map. The patient can see the clinic marker with the current location as shown in Figure 5(b).
The next step after the patient has determined which clinic and doctor to visit is take the queue number. The queue number is retrieved by clicking on the blue column. The blue column on represent that doctors are available on that day. The queue notification in Figure 5 (f) is given to the patient to provide real-time queue status information.

Route navigation to the clinic is shown in figure 5 (d). The applications the longitude and latitude of marker to use the Google Maps API support to navigate patient.

Consultation between doctor and patient is continued in chat form as in figure 5 (e). Consultation starts from the patient who determines which doctor is wanted.

V. CONCLUSION

We are presenting the implementation of Firebase and Google Maps API within an application. This application is expected to simplify the check-up cycles between doctor and patient including search, register, queue, consultation, and medical record.The result of this research show that Firebase successfully provide the real-time database, push notification, and storage. Google Maps API also successfully support the accurate map and location.

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