Development of The Personnel Monitoring System Using Mobile Application and Real-Time Database During the COVID19 Pandemic

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***Abstract*— Coronavirus disease 19 (COVID19) is a disease caused by the new coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This disease has infected almost the entire world with a total of 47.5 million sufferers and a death toll of 1.2 million people so that WHO categorizes it as a global pandemic. The COVID19 case in Indonesia still shows an increasing trend even though various prevention efforts have been made. Proven efforts to reduce the spread of COVID19 include limiting physical interactions between humans or physical distance, maintaining the cleanliness of hands and limbs by washing with soap, and limiting outdoor activities by staying at home. Several government and private agencies have required employees to report their health conditions via web pages. Real-time and accurate mobile applications can help prevent the spread of COVID19. This research will develop a real-time monitoring and command system using mobile applications and cloud computing technology. The application will collect GPS-based location data, the number of people in the vicinity identified via Bluetooth, and the user's body condition in the form of temperature and oxygen levels in the blood. User data is stored and processed in a real time database in cloud computing which can be accessed through an application on the user's smartphone. The database also stores data on Covid19 sufferers and where they live. The application provides alerts when in a crowd and notifies the status of the region the user is in. Advice is given by the app when the recording of the body condition points to the early symptoms of COVID19.**

Keywords*— personnel monitoring, mobile application, real-time database, COVID19

I. INTRODUCTION

COVID19 is a deadly disease caused by a new type of coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; previously known as 2019-nCoV). This disease causes acute respiratory failure [1] which can spread through free air [2] and has spread over a large area so that it is categorized as a pandemic disease [3][4]. The difference in symptoms that appear in each person makes it difficult to detect the spread of this virus. WHO data shows the number of sufferers of COVID19 at the beginning of November 2020 was more than 47.5 million with 1.2 million died [5], [6]. Although the number of new sufferers in several countries has decreased following lockdowns, a second attack has returned to areas that have experienced the first attack. The COVID19 case in Indonesia still shows an increasing trend even though various efforts have been made by the state and society.

COVID19 has impacted all areas of human life so efforts to prevent its spread are very important in addition to efforts to find a cure. The preventive efforts undertaken by the Indonesian government are outlined in the COVID19 Prevention Protocol19 [7] adopted from WHO, namely maintaining physical distance, reducing interactions, using masks when doing activities outside the home, washing hands with soap, and maintaining environmental hygiene. The COVID19 mobile monitoring application has been launched by the government under the name *Peduli Lindungi*. This application displays the location of sufferers of COVID19 and provides a status level alert for an area. This application also monitors the movement of users, but the level of accuracy is very low and even the error rate is very high, for example, the movement in Malang City was identified in the Gresik Regency area. Data updates are carried out weekly so that the actual data is not monitored by the application.

Such prevention efforts will have a positive impact if they are carried out in a disciplined manner by the entire community so that their implementation needs to be monitored in real-time. Independent monitoring can be done by utilizing a smartphone device with a monitoring application and processing data intelligently and quickly. Personnel data needed to enforce the COVID19 protocol include body temperature, tracking trips, identifying interactions with other people, and the health problems experienced. This data can be collected directly and in real-time using a smartphone [8][9]. Body temperature data can be measured with a thermometer and the results are inputted in the application provided. Traveling data can be tracked using GPS [10], [11] which can then be visualized on a digital map. Interaction between people is limited to not less than 1-2 meters which can be identified using Bluetooth. The results of monitoring are communicated to interested parties so that the necessary preventive steps can be taken.

Personnel location tracking can be done using GPS which can provide information about the position, speed, and time quickly, accurately, cheaply, anywhere on earth without depending on the weather [12]. GPS consists of three main

segments, namely the space segment consisting of GPS satellites, the control system segment consisting of satellite observation and control stations, and the user segment consisting of GPS users [10], [11][13]. PS has been embedded in the smartphone so that tracking using the application can be done with the assistance of GPS.

Identification of interactions between personnel can be done by utilizing Bluetooth which is a basic feature of smartphones. Bluetooth is capable of providing pairing services, data transfer, device identification, location detection, and others [14]. Android-based applications that run on smartphones using Bluetooth technology have been developed for data communication and object detection [15], [16].

Dynamic user movements and fast-changing environments result in fast data updates. The information obtained from data processing in the database system must be immediately available to the user so that he can know the conditions around him. Real-time data transactions from mobile users can be served by using a cloud-based real-time database, one of which is using Firebase Cloud Messaging (FCM) [17]. The service provided by Google is the integration of Google Cloud Messaging which is a push cloud to device communication service into Firebase. The four services provided by FCM are (1) data integration, a process of connecting interrelated data to enrich the information generated and stored in the warehouse so that it can be analyzed by OLAP; (2) data selection creates a target data set, selects a data set, or focuses on a subset of variables or a data sample so that the discovery will be analyzed to produce valuable information; (3) data transformation is a data transformation process to determine the quality of the results of data mining so that data can be changed as needed; and (4) data mining is a process of extracting information.

Cloud computing technology, which is a combination of internet and computing technology [18] allows fast data transmission to servers on the internet via a computer network that will process the data into information for users. The user's body condition is indicated by the temperature and oxygen content in the blood, the location at the time of measurement, the interaction with others obtained from the device identification via Bluetooth sent and in cloud computing. In this study, user data and data on COVID19 sufferers in an area are stored and processed in a cloud-based real-time database using FCM to produce information on the risk of COVID19 transmission for users. Messages in the form of the status of the user's location, warnings, and appeals are sent to the user when the data collected yields information on the increased risk of being attacked by COVID19.

II. METHOD

The development of the monitoring system is carried out using the Waterfall Model Methodology. The research stages for the development of a personnel monitoring system during the COVID19 pandemic using the Waterfall model are as follows.

A. Research and Development Procedures

The personnel monitoring system using a mobile application and real-time database with cloud computing technology was developed during the COVID19 pandemic to help prevent the spread of COVID19 more widely, especially in Indonesia. The development is divided into 3 parts, namely 1) the Android-based mobile application, 2) backend application, and 3) real-time database system with cloud computing technology. This system will be developed with the following research and development procedures:

1) Requirements Analysis and Definition. The analysis and definition of requirements are based on observation and testing of similar existing applications and assess the needs of efforts to prevent the spread of COVID19. A similar application observed is Peduli Lindungi which was developed by the Government of Indonesia in this case the Ministry of Communication and Information. Observation and testing resulted in the information that data updating was slow and the accuracy of user tracking was very low with an error rate of over 100km. The interaction detection feature provided in this application cannot be enabled yet. The application does not collect information on the user's health condition and the distribution map of COVID19 sufferers has not been provided in this application. The distribution map is very important for users to avoid to minimize the chance of being exposed to the COVID19 virus. This application does not provide information or guidelines for a healthy life that must be done by users such as wearing a mask, washing hands, and implementing a healthy lifestyle. Education to users is useful for reminding users who already understand and educating users who don't know and don't understand.

2) System and Software Design. Based on the development definition that has been made previously, the system and software design stage will create a home display, a menu of the number of sufferers in an area, a location tracking menu, a self-status menu, an interaction menu, and an information menu in the form of appeals and instructions. While the software design will define the software used in the development of this monitoring system.

The screen display on mobile application is used by displaying user information, patient distribution maps, the input of user-health conditions, location tracking data, interaction data, and information in the form of appeals and instructions. The information is processed and displayed in real-time which is supported by data processing in cloud computing using a real-time basis system. COVID19 application. A screen with a resolution of 720 x 1280 pixels was chosen to get a clear view, especially for displaying detailed map images. The displays will be divided into 4 design groups: (1) Home screen; (2) pandemic information (3) User info; and (4) Assistance. The flow of view can be seen in Fig. 1.

Home is used to provide information to the user that he has run the application. Pandemic information is used to convey information on the number and location of COVID19 sufferers in the form of numbers and digital maps.

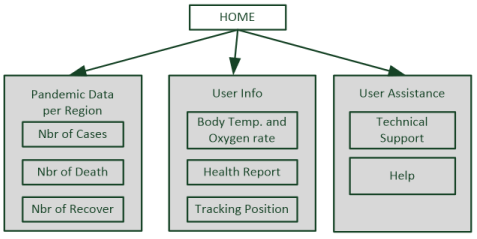


Fig. 1. The flow of User Interface

User info is used to enter and display information on the user's self, history, location tracking, and interaction

identification as well as information in the form of appeals or instructions to users from the backend application. Help is used to contact the admin if there are difficulties, errors, and unclear information received.

The display screen is a typical monitoring and instruction center screen accompanied by decision support features. The information displayed on the screen is users who violate the provisions of the COVID19 Spread Prevention Protocol will be followed up by sending an appeal, instruction, or warning. User information in the form of health conditions, location tracking, and interaction identification are displayed in groups based on predefined criteria.

3) Implementation and Unit Testing. At this stage, the realization of the system design that has been defined at the design stage is carried out. Mobile application development is carried out in an integrated development environment (IDE) application development program with appropriate programming languages such as Java, C #, and others. Mobile application development results will be tested on the Android Emulator and then tested on smartphones. The backend application was developed using web programming languages including JSON, HTML5, and others. This application and the database were developed on a web server in cloud computing.

4) Integration and System Testing. The units that have been developed are integrated into one system. The programmer will test every stage of integration and solve any problems that arise. After all the units are integrated and when testing by the programmers, no errors are found, the system is validated by an expert. Tests are carried out on each feature both on Android and a backend application according to the design made and the operating procedures defined in the use case. The integrated system configuration of all units is shown in Fig 2.

B. Operation and Maintenance

Systems and applications that have passed the validation test are then run on several users. The application of the first stage was carried out on 5 users from the research team consisting of lecturers and students. The second application was carried out on 25 users consisting of lecturers, students, and employees of the State University of Malang (UM). The implementation of the third stage was carried out on 100 users from the UM academic community. At each stage, an evaluation and revision will be carried out so that at the end of the third stage an application will be obtained that meets the monitoring needs of the prevention of the spread of COVID19 according to the protocol and according to the characteristics of the user. In the final test, the performance of the system will be measured using the criteria mentioned above.

C. Data Source

The data source is a measurement of the system based on system performance criteria, namely response speed, system stability, delay and latency of the data transfer process, and power consumption on smartphones, and the level of user satisfaction.

D. Data Collection Procedures

Data collection is done by using measurements in the system and questionnaires to determine the level of user satisfaction.

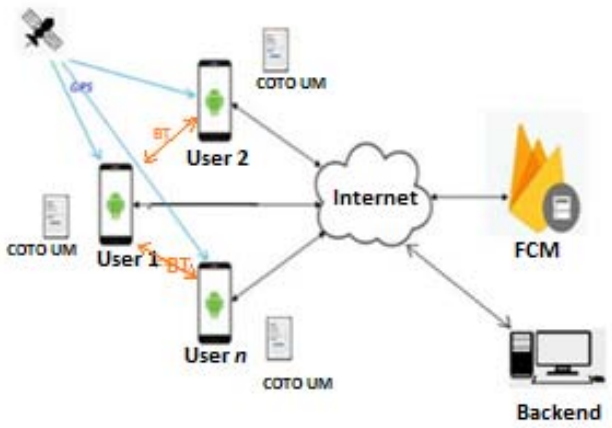


Fig. 2. Configuration of the personnel monitoring system

E. Data Analysis

The data analysis was carried out as follows. System response when several users use the system simultaneously. The responses recorded include error and bug data, response speed, system stability, delay, and latency in the data transfer process, and power consumption on smartphones. Data obtained based on variations in the number of users and variations in user activity. The level of user satisfaction is analyzed based on the expectations of the users and the level of fulfillment of these expectations by the system.

III. Result and Discussion

The personnel monitoring system consists of three parts as mentioned above, that are COTO UM Android application, the administrator backend application, and the cloud-based real-time system. The backend was developed together with the database system in the cloud, therefore both will be discussed together as follows.

A. COTO UM Android Application

The application on smartphones with the Android operating system is named COTO UM which stands for COvid Tracking of the State University of Malang. This application has the following features.

The front page of the application as well as a page to enter the application or login page. On this page, the application logo and the UM logo are embedded. Username uses the telephone number used when registering. The position of the user will be detected when logging in using the GPS equipment on the user's smartphone. This data is sent and recorded in the cloud database system. The front page which also functions as the login page is shown in Fig. 3 a) User registration using a phone number and verified using One Time Password (OTP). The OTP code is sent via SMS from the server to the registration page shown in Fig. 3 b).

The body temperature detection page and blood oxygen level is a page for manually entering temperature and oxygen level data. The temperature and oxygen content in the user's blood is measured using a thermometer and oximeter, consecutively. Users enter this measurement result data into the application manually and routinely every day at the hours set by the user institution.

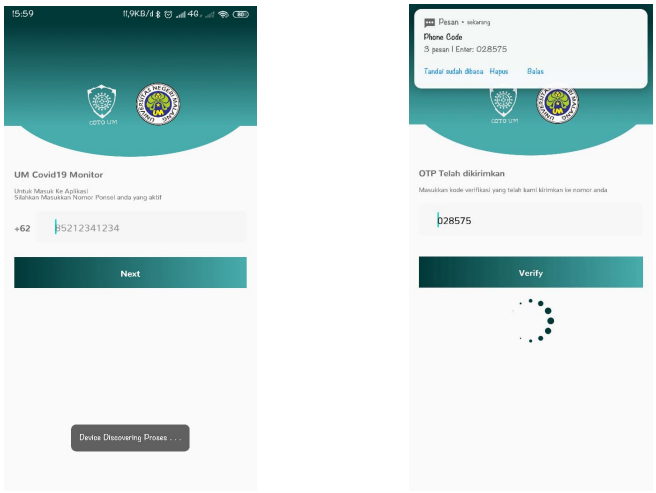


Fig. 3. Welcoming page a) Login page, b) Registration page

The identification page detects the presence of a smartphone device in the vicinity of the user. The function of this menu is to find out whether the user is in the crowd, assuming that each smartphone is carried by one user. Detection of other smartphones can be obtained if the Bluetooth device on each smartphone is activated. Therefore this application will ask the user to activate Bluetooth when starting the application. The smartphone device identification display is shown in Fig. 4. A message notification will appear when the user is in the orange or red area and the Bluetooth device detects several devices around the user. Fig. 5 a) shows the status and alerts sent to the user when the smartphone detects Bluetooth from another smartphone. However, if the application does not detect another smartphone, a safe status message will be sent to the user as shown in Fig. 5 b). The application can turn Bluetooth on and off for battery management.

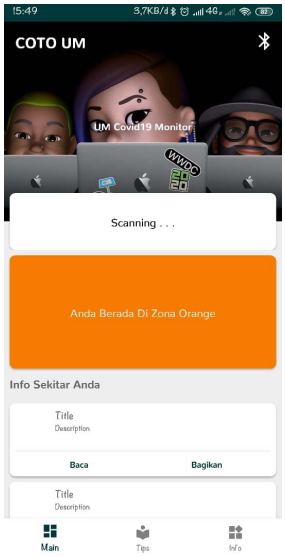


Fig. 4. Bluetooth detection in progress

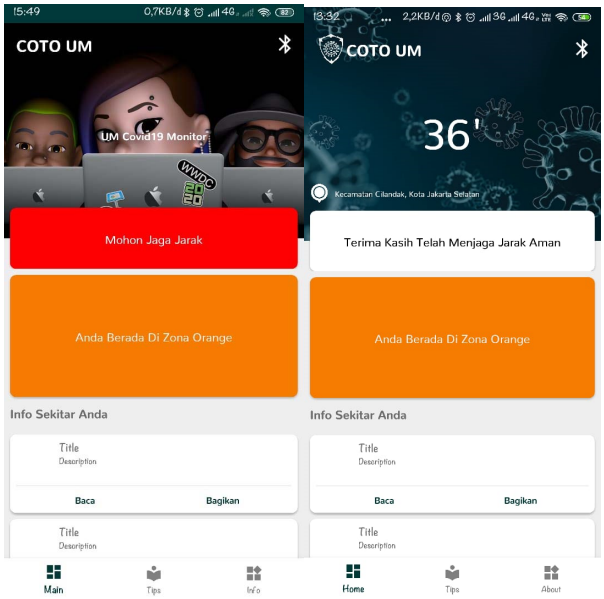


Fig. 5. Detection results in a) Device detected, b) No device detected

The mobile application also provides warnings or warnings if the user is in an area with a high risk of infection, namely the orange area and the red area. The status of an area is determined by the presence of COVID19 patients. The notification that appears on the screen is shown in Fig. 6.

Fig. 6. Transmission risk status, a) orange, b) merah, c) bantuan

B. RealtimeDatabase System

The database system used in the development of the monitoring system is a database system provided on a cloud network by a cloud service provider. FCM was chosen because it offers many advantages for the development of smartphone applications based on Android [19]. The FCM system integrates database and machine learning and is supported by a smartphone program emulator and web-based application development. The database structure for managing the monitoring data is shown in Fig. 7. The data are grouped by province, district, and sub-district and can be further developed per village or smaller area according to the availability of data on COVID19 sufferers.

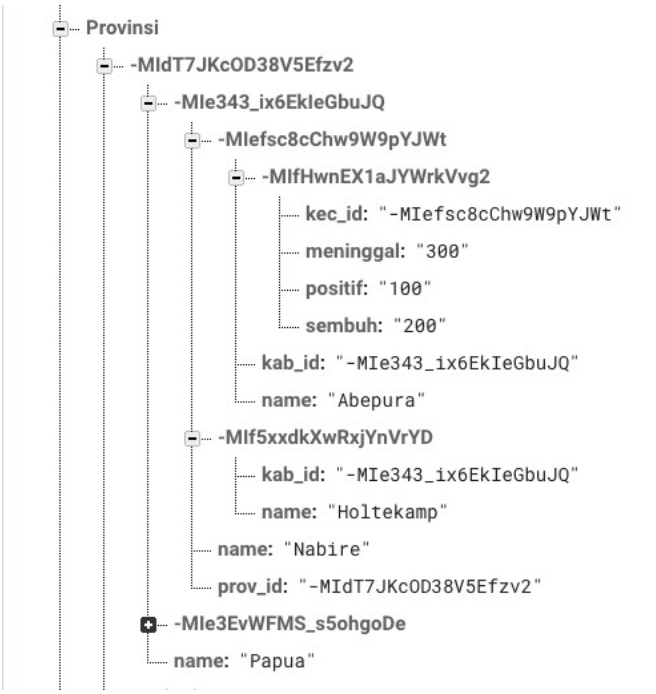


Fig. 7 Monitoring database structure

Location data for COVID19 sufferers are taken from the official website of the COVID19 Response Task Force which is posted on the website http://covid19.go.id which provides data access to the national COVID19 database system. Obtaining accurate data in Indonesia is very difficult because the detailed map of the patient's location (RT, RW, kelurahan /village) is kept secret and only shares cumulative data on patients per village. The only data on COVID19 sufferers nationally that is open to the public only comes from the task force which is then uploaded on various pages of government agencies and other institutions. The data source for the spread of COVID19 patients used in this monitoring system is taken from the official government website that provides an application platform interface (API). However, the data in this system can be developed by manually entering data from trusted sources (hospitals or others) for limited interest in certain organizations or companies.

The admin interaction with the system in FCM has been built to make it easier to manage the monitoring system, especially the backend system application. The configuration of tables and data structures needed to store data and retrieve data from other websites using the API is carried out by the web admin through this page. Fig. 8 shows the admin page that contains COVID19 data stored in the database system.

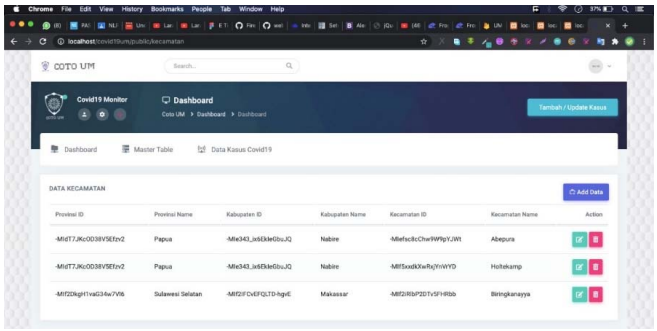
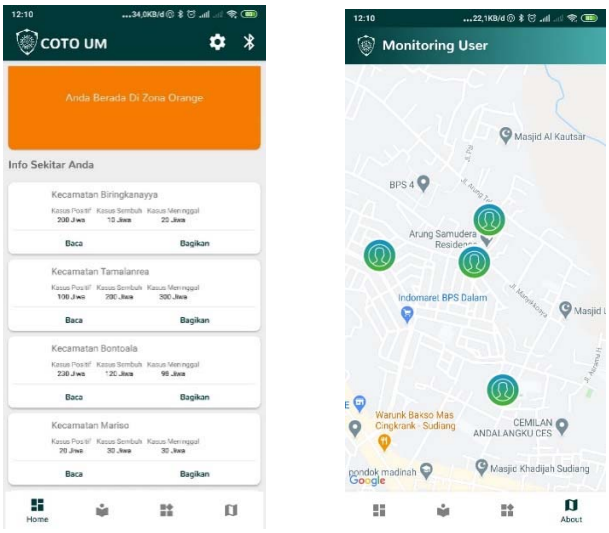


Fig. 8 Data and distribution of COVID19 patient saved in the database

C. *Monitoring and Tracking Test*

Limited application trials have been conducted to see the system response and the ability to collect data. The test is carried out on the status of the area where the user is currently in transmission and the user's location is using GPS. Fig. 9 a) indicates the status of the transmission at the user's location. The application also displays data on COVID19 sufferers who are currently being treated, cases recovered and cases died. These results are in line with the OECD provisions on tracing and tracing COVID19 using smartphones [20] and also provisions in several countries [21] including the European Union [22]. Meanwhile, the user's location can be shown in real-time in the application as shown in Fig. 9 b). The accuracy of this location is highly dependent on the quality of the GPS signal detection by smartphone devices. Orange status is displayed in the form of a large orange box with orange color status written on it. The delay profile for updating data to the user appliation is shown in Fig. 10 where the average is 2.54 seconds.



(a) (b)

Fig. 9. (a) transmission status of the user's location, (b) the user's real-time location

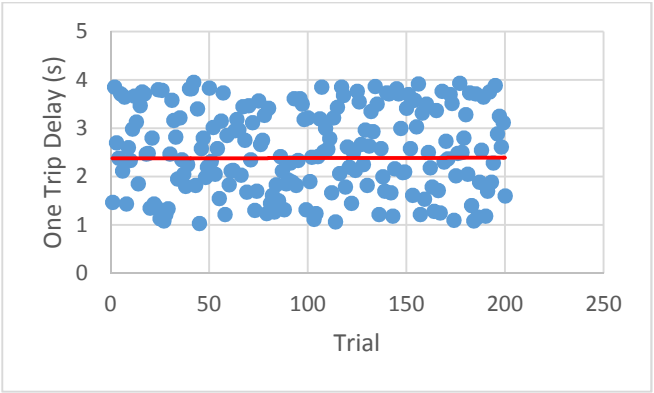


Fig. 10 Delay profile for one trip data update at the user

IV. CONCLUSION

The personnel monitoring application during the COVID19 pandemic has been developed and can detect the user's location and detect the presence of other people through Bluetooth detection on smartphones. The development and implementation obstacles faced at this time are the difficulties in obtaining map data of the location of the distribution of COVID19 sufferers. The results of monitoring can be used for various purposes of personnel monitoring in

dealing with and solving problems during the COVID19 pandemic. Some important points that will be carried out are a refinement of smartphone applications, improvement of database systems, updating of data on the distribution of COVID19 in Indonesia, especially in Malang and East Java starting from dummy data and replaced simultaneously with real data, development of temperature and oxygen level detection tools and devices with a Bluetooth connection with the smartphone.

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