Smartphone-based GNSS Method for Covid-19 Information on Android (Case Study: Surabaya City)

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Abstract. Coronavirus disease 2019 (Covid-19) is the respiration disease that can be transmitted from individual to another. There have been 3906 ODP (individual on monitoring) cases, 3303 PDP (patient under surveillance) cases, 2918 confirmed cases, 766 recovered patients, and 282 deaths in Surabaya, as recorded on June 6th, 2020. GIS (Geographical information system) is a science based on computer software, to provide digital form information and the earth's geographic surface analysis. GNSS (global navigation satellite system) is the positioning system method using satellite, which can be used by a lot of people at the same time and designed to obtain three-dimension position. The combination of Smartphone’s GNSS positioning and the spatial data of Covid-19 distribution in Surabaya is expected to be able to give useful information about health condition toward citizen, especially about Covid-19 pandemic via application based. The outcome is a color-level based distribution of Covid-19 cases which can be accessed android smartphone. Sub district with the highest rate of Covid-19 cases does not necessarily have proper health protocol facilities, and so does other sub districts with high rates of Covid-19 cases. In fact, none of Covid-19 referral hospital located in the sub district with high rate of Covid-19 cases. Based on the results of the questionnaire, the applications namely “Cegah Covid-19 Surabaya” has received good responses. This application is currently able to run on Android smartphones with the versions of Android 10, Pie, Oreo, Nougat, Marshmallow, and Lollipop.

Keywords: Android Application, Geographic Information System, GNSS Smartphone

1. Introduction
Coronavirus disease 2019 (Covid-19) respiratory disease that can be transmitted from individual to another with close range contact in less than 2 meters through droplet which produced when an infected person coughs or sneezes (CDC 2020). Covid-19 can also infect individuals who touch their mouth, nose or eyes after they have a direct contact with an object or surface which contained virus (CDC 2020). As for June 6th 2020, there have been 3906 ODP (individual on monitoring) cases, 3303 PDP (patient under surveillance) cases, 2918 Covid-19 confirmed cases, 766 recovered patients, and 282 deaths in Surabaya (East Java Provincial Government 2020).

Geographic Information System (GIS) is a science based computer software, to digitalize and analyze the geographic of earth surface for a precise and accurate spatial information (Suryantoro 2013). GNSS is the method of positioning system using satellite, which can be used by a lot of people at the same time and designed to obtain three-dimension position. Nowadays, navigation and geodetic are the types of
GNSS technology which generally used. Both android and IOS smartphones have a GNSS navigation type. Research about the accuracy value of GNSS has been conducted by Cahyadi et al (2019). This study will identify the accuracy value of GNSS on smartphones which will be integrated with the applications conducted in this research.

Covid-19 data cases in Surabaya represents that Surabaya has unfavorable health condition lately. The objective of this research is to design Android-based software as a medium for health information, especially about Covid-19 in the city of Surabaya, to analyze the distribution of Covid-19 cases, and to recognize the GNSS accuracy value of the smartphone used. There are some features in this application such as the map of Surabaya’s Covid-19 distribution and the user position to be generated by GNSS on smartphone to give the actual information about Covid-19 around the user. There are other information about medical facilities distribution as well, such as hospital, public health center, and health protocol public facilities.

2. Study Area
The study case of this research is located in Surabaya, East Java. Geographically located at coordinate 7° 9’ - 7° 21’ South Latitude and 112° 36’ - 112° 57’ West Longitude, Surabaya was chosen because it has the largest corona virus case in East Java by June 6th, 2020.

![Figure 1. Study case area](image)

3. Datasets and Equipments
Datasets used in this research are as follows:
- The Surabaya’s district and sub district administrative boundaries, downloaded from open street map website.
- Surabaya’s Covid-19 distribution on June 6th, 2020 from Surabaya City Government which accessed through “Surabaya Lawan Covid-19” website
- The Surabaya’s medical facilities distribution, such as hospital and public health center, from Surabaya City Government which accessed through “Surabaya Lawan Covid-19” website
- The Public facilities distribution, such as potable washing stand, hand sanitizer, and sterilization cubicle from Surabaya City Government which accessed through “Surabaya Lawan Covid-19” website

Hardware equipment used in this research are as follow:
- Laptop Asus Q543U
- Smartphone Realme 5 Pro

Software equipment used in this research are as follows:
- Spatial data processing software
• Flutter
• Visual Studio Code
• Android Studio
• GPS Essentials
• Adobe Photoshop CS3
• Microsoft Office 365

4. Data Processing

Figure 2 shows the accumulated data consist of administrative boundaries, Covid-19 distribution, medical facilities distribution such as hospital and public health center, and public facilities such as potable washing stand, hand sanitizer, and sterilization cubicle. This data set will be processed into a spatial data.

![Diagram of data processing](image)

**Figure 2.** The diagram of data processing.

The data of Covid-19 distribution are available based on sub district administrative, and the data inputed as attribut data for polygon are based on sub district administrative boundaries. Since there are no coordinates from the data of the health facilities distribution and public facilities, it is necessary to add the coordinates and address information of the location using Google maps. Furthermore, the coordinates are plotted on the polygon of administrative boundaries. In order to represent the level of ODP, PDP, and Covid-19 confirmed cases, the data have been divided into 5 level based on colours level which is 0, 1-20, 21-40, 41-60, and >60, the colours level distribution of Covid-19 cases refers to the Map of the Distribution of Covid-19 Cases in Jakarta from DKI Jakarta Health Office accessed on June 1st, 2020, which divided into 5 colour levels per sub district, with 0 cases, 1 to 20 cases, 21 to 40 cases, 41 to 60 cases, and 60 to 89 cases. Here, 60 to 89 cases were modified to be more than 60 cases to match the number of cases in Surabaya City with the highest rate of 128 cases. Then the data layer have been converted to KML, JSON, and GeoJSON data format, enable it to be read by the flutter for
the application design. The KML data format have been plotted on Google maps to test the display of spatial data on Google maps as an estimation results for the display later on.

There are two common methods for application coding result known as debug, namely debugging using simulator and debugging with a smartphone device. The debugging method using a simulator need should be done using Android Studio to test the coding result for older-version Android. Meanwhile, debugging with a smartphone is done to test the coding result on the latest version of Android, which is Android 10.

In the application making process using flutter and visual studio code as an editor, the first step was to get Google Service by obtaining an API key and registered into https://cloud.google.com/maps-platform/page using a gmail account. Afterwards, the API key was entered into the androidmanifest.xml file in the android>app>src>main folder.

The KML, JSON, and GeoJSON format data, the picture for icon and marker above the folder assets have been imported into the coding. Then, a coding folder was created in the folder lib with the extension .dart for each map page such as the COVID-19 distribution, the medical facilities distribution, and the public facilities distribution. After making sure that the simulator or smartphone has been connected, the debugging test was conducted by pressing F5 button.

5. Results and Discussion

5.1. Spatial Data Result and Analysis

Figure 3(a), 3(b), and 3(c) are the results which represents Surabaya’s Covid-19 distribution, there are 5 levels based on its color description in the Table 1.

![Figure 3(a), 3(b), and 3(c)](image)

Figure 3. The distribution of ODP cases (a), The distribution of PDP cases (b), and The distribution of confirmed cases (c)
Table 1. Color description of the COVID-19 distribution

| Level | Color | Description   |
|-------|-------|---------------|
| 1     | 0     | 0 case        |
| 2     | 1-2   | 1-20 cases    |
| 3     | 3-4   | 21-40 cases   |
| 4     | 5-6   | 41-60 cases   |
| 5     | 7-8   | >60 cases     |

Based on Figure 4(a) the highest ODP cases occurred in Wonokromo sub district with 106 cases and the lowest rate occurred in Tambak Oso Wilangon sub district with 0 case. Based on Figure 4(b) the highest PDP cases occurred in Tanah Kali Kedinding sub district with 68 cases and the lowest occurred in Kedung Cowek sub district with 2 cases. Meanwhile, based on Figure 4(c) the highest confirmed cases have occurred in Kemayoran sub district with 128 cases, while the lowest occurred in Genting Kalianak, Manukan Wetan, and Romokalisari sub district with 0 case.

Figure 4 The diagram of ODP cases (a), The diagram of PDP cases (b), and The diagram of confirmed cases (c)

The results represented in Figure 5(a) shows that the level 3 ODP sub district is close to the level 2 or 4 ODP sub district. From Figure 5(b), it can be seen that the level 4 PDP sub district occurs beside the level 5 PDP sub district, yet more cases occur closer to the level 4 PDP sub district. However, based on Figure 5(c) there are few level 5 confirmed sub district located closer to the level 4 of confirmed sub district. After further analysis, several level 3 are close to level 5, and some of them are nearly reach level 4.
Figure 5. Zoom in ODP cases (a), Zoom in PDP cases (b), and Zoom in confirmed cases (c)

Figure 6 and Figure 7 show the distribution of medical facilities such as hospital, public health center, and public facilities distribution such as potable washing stand, hand sanitizer, and sterilization cubicle which have been plotted. The intended medical facilities here is the medical facilities designed by Surabaya City Government to handle Covid-19 cases, and public facilities here are public facilities created by the Surabaya City Government to prevent the increasing transmission of Covid-19 which is plotted at the district boundaries in Surabaya, with the symbol and description explained in Table 2.
Table 2. Symbol description of medical and public facilities

| Symbol | Description                        |
|--------|-----------------------------------|
| 🚑     | Hospital                          |
| 🟢     | Public health center              |
| 🥧     | Portable washing stand            |
| 🍀     | Hand sanitizer                    |
| 🍀     | Sterilization cubicle             |

From the table, it can be seen that the medical facilities distribution in the West area of Surabaya are less than other regions, even though it is quite large compared to other region. The public facilities in the West area of Surabaya also are less than the other. Public facilities generally accumulated in the Central, North, and South of Surabaya, yet public places can provide these public facilities themselves.

Table 3. Five sub districts of the highest level of confirmation

| Sub district | ODP case | PDP case | Confirmation case | ODP level | PDP level | Confirmation level | Number of Public Health Facilities | Number of Public Health centres | Number of Hospitals |
|--------------|----------|----------|-------------------|-----------|-----------|--------------------|-----------------------------------|-------------------------------|---------------------|
| Kemayoran    | 19       | 42       | 128               | 2         | 4         | 5                  | 3                                 | 0                             | 0                   |
| Kali Rungkut | 40       | 56       | 113               | 3         | 4         | 5                  | 8                                 | 2                             | 0                   |
| Kedung Baruk| 34       | 31       | 82                | 3         | 3         | 5                  | 3                                 | 0                             | 0                   |
| Jepara       | 19       | 23       | 71                | 2         | 3         | 5                  | 2                                 | 0                             | 0                   |
| Mojo         | 70       | 54       | 70                | 5         | 4         | 5                  | 9                                 | 1                             | 0                   |

From Table 3, five sub districts with the highest levels of confirmation have PDP levels below one to two levels below, and ODP levels at the same level to three levels below. Based on the value, the number of confirmed cases is quite far from the number of ODP or PDP cases in the sub district. It is possible because the status of ODP or PDP patients have changed their status to confirmation. Then, it seems that the number of public health protocol facilities does not affect the number of confirmed cases, because sub districts with 8 or 9 health protocol facilities have its potential to be a sub districts with the highest number of confirmed cases.

5.2. Application Designing Results and Analysis

The application that has been designed is called “Cegah Covid-19 Surabaya” with the main feature to provide notification about Covid-19 information around the user based on smartphone’s GNSS. Therefore, if the user opened this application, they will be asked to turn on the smartphone’s GNSS to find out the user’s location. Then, when the user opened the distribution menu, they will be directed to the city of Surabaya with the blue point as the user's current location.
There are three main menu, the first feature is Covid-19 distribution menu as displayed on Figure 8, which includes ODP, PDP, and confirmed distribution cases in Surabaya. This menu can be clicked as option to display ODP, PDP, or Covid-19 confirmed cases distribution, and user can also tap each sub district polygon to display the specific information. Legend buttons and buttons to display the total of Covid-19 cases in Surabaya are also available.

The Second feature is medical facilities distribution menu as displayed on Figure 9, which contains referral hospital and public health center for Covid-19 cases. Markers on the map can be clicked for the detailed information because it is based on the Google Maps service to show the route to the intended point. Legend-display buttons are also available.

The third feature is health protocol public facilities distribution menu as displayed on Figure 10, which includes potable washing stand, hand sanitizer, and sterilization cubicle. Markers on the map can be clicked for the detailed information from the marker. This feature is similar to the medical facilities menu, because it is based on the Google Maps service which enables to show the route to the intended point. Legend-display buttons are also available.

**Table 4. Smartphone GNSS Accuracy Value**

| Smartphone     | Accuracy Value | Number of Satellite | Number of Fix Satellite |
|----------------|----------------|---------------------|-------------------------|
| Realme 5 Pro   | 3.79 m         | 17                  | 11                      |
| Samsung Note 10| 3.05 m         | 26                  | 20                      |
| Samsung S8     | 3.00 m         | 24                  | 23                      |
| Asus Zenfone 5 | 3.22 m         | 25                  | 15                      |
| Asus Zenfone 3 Max | 3.90 m     | 8                   | 8                       |

On smartphones, the accuracy value of GNSS can be recognized using GPS Essentials application. The displayed accuracy value can be recognized when a fix position is reported, depends on the number of satellites that can be seen and fixed. The more satellites can be seen and fixed the better it us for this
value. Based on the results as in Table 4 from the test of five smartphones, the lowest accuracy was obtained by Samsung S8 with an accuracy value of 3.00 m with 24 visible satellites and 23 fixed satellites. Meanwhile the highest value was achieved by Asus Zenfone 3 Max with an accuracy value of 3.90 m with visible satellites, and the number of fixed satellites is 8. Therefore, lower accuracy value means better accuracy results.

The application then distributed to be tested by several users on several types of smartphones and questionnaires to find out the opinions from several respondents. The results from 20 respondents are as follows.

![The android system version used](image)

**Figure 11.** Android version used by respondents

**Figure 11** shows the versions of Android operating system used by respondents, and it can be seen that most users use Android Pie version.

![Does the application "Cegah Covid-19 Surabaya" help in accessing information related to Covid-19 in Surabaya](image)

**Figure 12.** Results Whether Application Helpful or Not

Some questions were asked to see if the application gets a good response as shows in **Figure 12.** The result shows that 20 respondents thought "Cegah Covid-19 Surabaya" application has helped them to easily access information related to Covid-19 in Surabaya, indicating that this application has received good responses.

6. Conclusions

Based on research and discussion above, the conclusions are:

- "Cegah Covid-19 Surabaya" application able to detect user's location and display the complete page on the android version of 10, Pie, Oreo, Nougat, Marshmallow, and Lollipop. Based on the questionnaire answers from 20 respondents, the results showed that the application obtained good responses from users who have tested it.
- The highest ODP cases occurred in Wonokromo sub district with 106 cases and the lowest cases occurred in Tambak Oso Wilangon sub district with 0 case. The highest PDP cases are occurred in Tanah Kali Kedinding sub district with 68 cases and the lowest occurred in Kedung Cowek sub district with 2 cases. Meanwhile, the highest confirmed cases occurred
in Kemayoran sub district with 128 cases and the lowest occurred in Genting Kalianak, Manukan Wetan, and Romokalisari sub district with 0 case.

- Sub district with lower Covid-19 cases usually occurred near another sub district with similar case rate, either one level below or above. The number of health protocol public facilities does not always correspond with the highest rate of Covid-19. However, the sub district with a lot of health protocol public facilities might become the sub district with the highest rate of Covid-19 cases. As for the distribution of Covid-19 referral hospitals, none of them located in the sub district with the highest Covid-19 cases rate.
- The five smartphones tested for the best accuracy value were Samsung S8 with an accuracy value of 3.00 m with 24 visible satellites and 23 fixed satellites, while the worst was Asus Zenfone 3 Max with an accuracy value of 3.90 m with the number of visible satellites and the number of fixed satellites of 8

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