Development of Model Optical Distribution Point Location Detector System with GIS Approach Method- Case Study in PT. Telkom Witel Bandung

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ABSTRACT

Principally, the validation of the location of the Optical Distribution Point (ODP) device is carried out to match the field data with the data at the center of the system. The current problem is that there are frequent shifts in ODP location data points in the field with the data system at PT. Telkom Witel Bandung because the existing detection system is still manual. This condition directly disrupts the performance of the communication network system so that service to customers is reduced. Therefore, it is necessary to develop a digital and automatic detection system for detecting ODP locations through the use of the Geographic Information System (GIS) method. This method can increase the accuracy and efficiency of the travel time to the ODP location point. This study aims to increase the accuracy of the ODP device at different locations through the development of a location point detection system using the geographic information system method approach. The testing technique carried out in this study used two methods, namely the direct method and the GPS field measure method. The test results on the developed geographic information system have been successfully integrated with Google Maps and the GPS sensor has been successfully sent to the application. The results of the previous system obtained a location accuracy rate with an error percentage value of 3.6%. The results of this development system obtained an error percentage value of 1%. This 1% error result was achieved because GIS was able to update the geographical map of the location at any time so that it was able to accurately and quickly show the position of the ODP location points. Based on the results of the final test, shows that the system developed in this study produces a better accuracy value than the previous system. In the future, this developed system can be implemented to accurately detect ODP locations for larger numbers and larger areas.

1. Introduction

PT. Telkom Witel Bandung is a telecommunications services company that provides telephone and internet communication network services (Telkom Indonesia, 2022). One of these network services uses fiber optic cable transmission as a data transmission medium, which is better known as Fiber to The Home (Hanafiah *et al*., 2006). This FTTH network is the latest access network that is directly connected to customers via fiber optic cables so that each access point will be identified (Zulfikar *et.al*., 2022).

One of the most important devices in the FTTH network is the Optical Distribution Point (ODP) which consists of an optical pigtail, connectors, and a splitter room (Sihotang *et al*., 2018). This type of device is an optical network termination placed at several locations connecting fiber optic distribution cables and drop cables directly to the customer. The accuracy of the information sent from the ODP device installed at each point of the installation location is needed by PT. Telkom Witel Bandung to determine network performance and ensure the service continues. This statement is strengthened by research (Apriyanto *et.al*., 2022) which shows that indirectly the length of time and speed in detecting an ODP location will reduce network load. The increase in network performance here can be measured based on the processing of data received from each ODP location via GIS by admins and technicians. The problem that is often faced so far is the occurrence of shifts and inaccuracies in the degree of ODP location points between field data and data centers in this company. Another impact of this problem is that the data validation process is done manually where technicians have to search for ODP locations

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one by one, so it takes a long time. Field data validation is carried out for adjustments between existing data in the field and existing data in the system, both in the form of old and new customers.

In this research, the system model designed consists of hardware and software. In terms of hardware, the system is equipped with an ESP32-type microcontroller as a data processing center for ODP location points and travel time received from various sensors placed in various locations. In terms of software, this GIS application receives various point location information and travel time from GPS sensors connected in a distributed manner via a connection between the admin and technicians. The novelty value of this research lies in the hardware integration, namely placing a microcontroller on the ODP device in the field which is connected to GIS, thereby enabling accelerated data transmission speed and accuracy in detecting the ODP location which has never been done in previous research. Several previous studies have developed and implemented methods to detect ODP location points accurately and quickly. In research conducted by (Yusuf *et.al.*, 2019) the waterfall method has been applied to detect ODP location points through Android device monitoring, although there is still no information regarding whether the process of sending ODP location data is carried out in real-time or not. Other research (Sintyarianti *et.al.*, 2017) applies the black box testing method to detect ODP location maps through web and Android-based monitoring. Meanwhile, in this research, the development and improvement are more focused on access to the speed of sending ODP location data in real-time, accurately, and relatively quickly. This is done through an automation method approach by adding an embedded system in the form of a microcontroller as a center for field data processing in real-time and automatically which is monitored at all times via various existing device platforms.

2. Literature Review

The development of the system model in this study refers to research that has been done before. As has been done by research (Utami *et al.*, 2022 and Supriatin *et al.*, 2021) where the results of their research are more towards the development of the use of information systems in processing information data related to ODP locations even though data processing is still done manually (Yusuf *et al.*, 2019 and Sintyarianti *et.al.*, 2017). Therefore, steps to solve the problem so far have been carried out by developing a system by adding the design of automation detection technology through the GIS method by utilizing satellites and GPS sensors. Through system development, the goal to be achieved from this research is to make an accurate OPD location detection device to make it easier for companies to monitor network conditions and improve service to customers. The real contribution of the results of this research is that it can be implemented for a larger number and area and can be used not only for PT. Telkom Witel Bandung only but for other similar companies (*Putri et al.*, 2018 and Faizi *et al.*, 2015).

3. Research Method

The methodology used in this research consists of software system design, and hardware system design accompanied by a system testing flow to measure device accuracy. In general, the stages of the research methodology are shown in Figure 1.

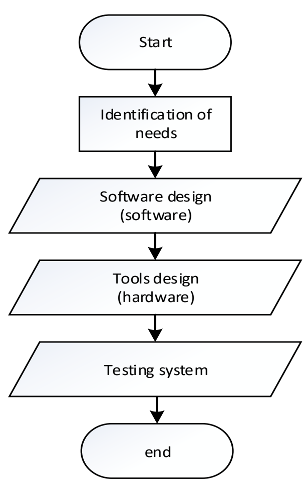


Figure 1. Research flowchart

3.1. Programming

At this stage, a software program design is carried out and the program source code is created using the Hypertext Preprocessor (PHP) programming language, creating a database using MySQL as data storage and processing using microcontroller programming. The design stages of this software consist of a program to identify the name of the ODP at each location and integration of Google Maps, the program list of which is described below.

Identification name of location ODP:

```
<?php
namespace App\Http\Controllers\apps;
use App\Http\Controllers\Controller;
use Illuminate\Support\Facades\Auth;
use Illuminate\Http\Request;
use App\Models\Odp;
use App\Models\odp_location;
use App\Models\User;
class DashboardController extends Controller
{  public function __construct()
   { $this->middleware('auth');
   }
   public function index()
   {return view('backend.dashboard.index');
   }
   public function cari(Request $request)
   { $nama = $request->nama;
      if ($nama=="") {
         return '<div class="alert alert-danger">Nama ODP Harus diisi</div>';
      } else { $odp = Odp::where('name, 'like', "%" . $nama . "%")->paginate(15);
         return view('backend.dashboard.car, compact('odp'))->with('i', (request()->input('page', 1) - 1) * 10);
      }
   }
   ……
```

Integration to Google Maps:

```
<script
src="https://maps.googleapis.com/maps/api/js?key=AIzaSyAuQk1JDJcLp0qb9qi5CXrck-G1Fn1H4ww"
async defer></script>
<script type="text/javascript">
$(document).ready(function() {
$("#formRute").submit(function(e) {
    e.preventDefault();
    //ambil value dari form input asal
    var asal=$("#asal").val();
    //ambil value dari form input tujuan
    var tujuan=$("#tujuan").val();
     //cek apakah asal dan tujuan kosong
     if (asal=="") {
      alert("Tempat asal tidak boleh kosong!");
     }else if (tujuan=="") {
      alert("Tempat tujuan tidak boleh kosong!");
     }else {
        var directionsService = new google.maps.DirectionsService();
        var directionsDisplay = new google.maps.DirectionsRenderer();
        var mapOptions = {
          zoom:12,
        }
        var map = new google.maps.Map(document.getElementById('map'), mapOptions);
        directionsDisplay.setMap(map);
        directionsDisplay.setPanel(document.getElementById('panel'));
….
```

3.2. Design of Device

At this stage, the hardware design and realization process refers to the system block and circuit schematic shown in Figure 3. The location coordinates and travel time in determining the ODP location are detected by the GPS sensor where the results are then processed by the ESP32 microcontroller which is connected in real-time to the central database, which is monitored via smartphone devices.

3.3. Testing of system

The flow of the test model for testing and measuring devices that have been developed and designed, the testing stages can be seen in Figure 4 which refers to 3 test parameters, namely determining the ODP location point, travel time to the ODP location, and the process of sending data to the server. The development of this detection device is an improvement over the ODP location detection system which still operates manually. The difference between the system being developed and the previous system can be seen based on the flow of system development as shown in Figure 2.

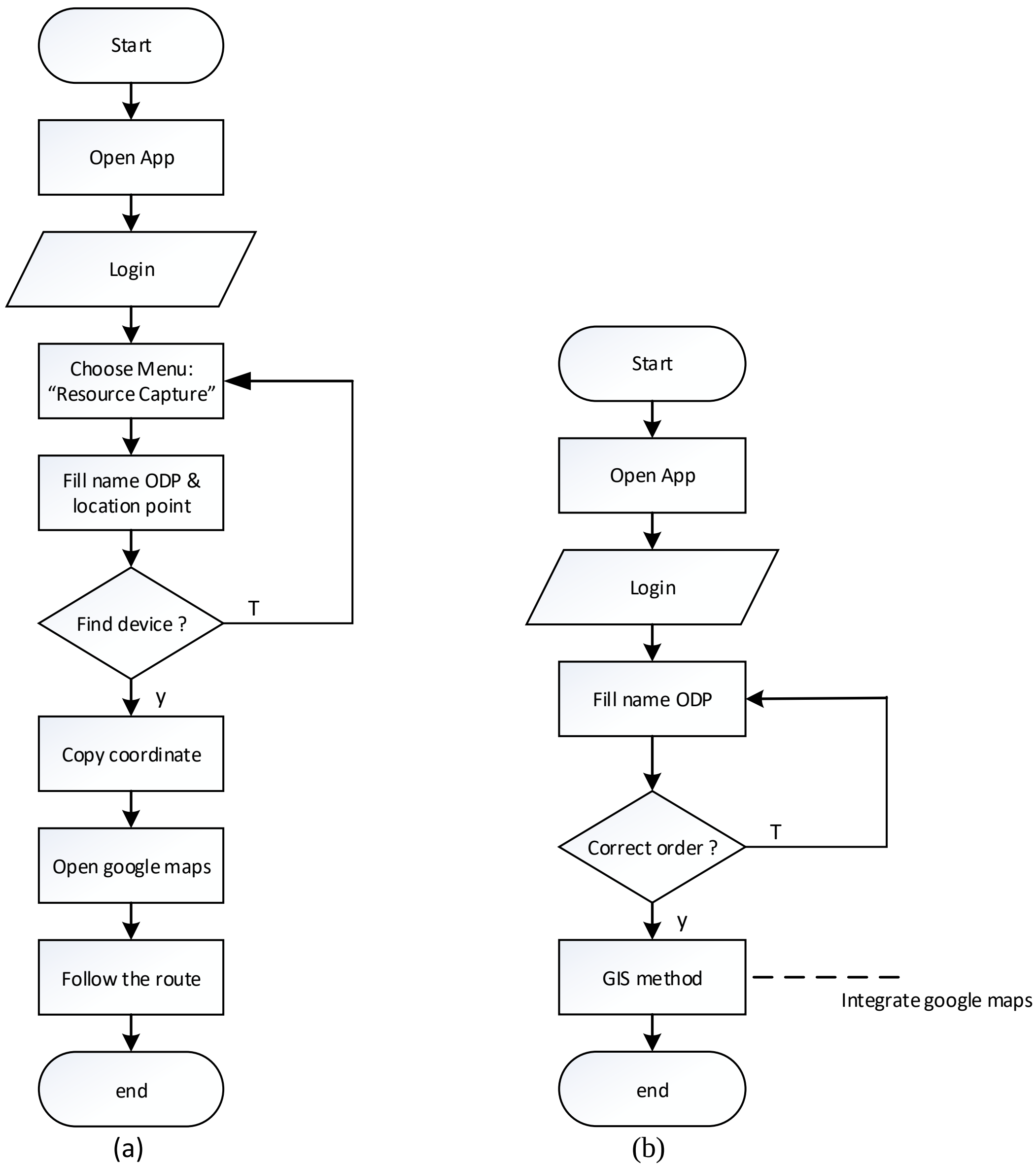


Figure 2. Flowchart of system detection ODP: a. before development, b. after development

Based on Figure 2 above, the system starts by logging in using the provided username and password. Next, to find the ODP location point, the user opens the resource capture menu and enters the identification of the ODP name to be validated in the device location section (Pramono, 2022). If the location you are looking for is correct, then it will display the ODP location data information. In the previous system (figure 2. a) there was no integrated process with Google Maps, so you had to copy the coordinates first to get the route to that location. While the results of the system development according to Figure 2. b on the device added software to include the GIS application as a medium to assist and make it easier to determine the coordinates and location of the ODP accurately and more quickly (Fatkuroji *et.al.*, 2022).

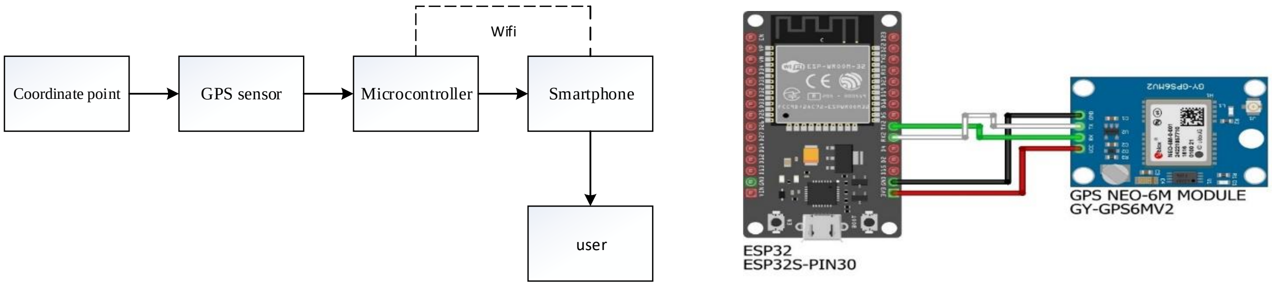


Figure 3. Design of hardware system: a. diagram block, b. circuit

Based on Figure 3 above, the hardware design of this detection system is built from several components including:

a. Sensor GPS type Neo 6m
This type of GPS sensor is enabled to provide location point information from the device which can be in the form of latitude and longitude angles.

b. Microcontroller
The microcontroller used in this study is the ESP32 type microcontroller used to process input data from the GPS sensor which is then used as a medium for sending data to the server.

c. Smartphone
Android smartphones are used to display the results of data on servers that have been sent and processed using Android so that it is easy to use and displayed in full.

4. Results and Discussions

This study focused In this research, the parameters that will be measured and become indicators of system performance include the level of location accuracy, travel time for ODP location points, and the process of sending sensor data to the server. The flow of the stages of testing and measuring these parameters can be seen in Figure 4 where each stage shows the process for determining the target value according to the purpose of this research.

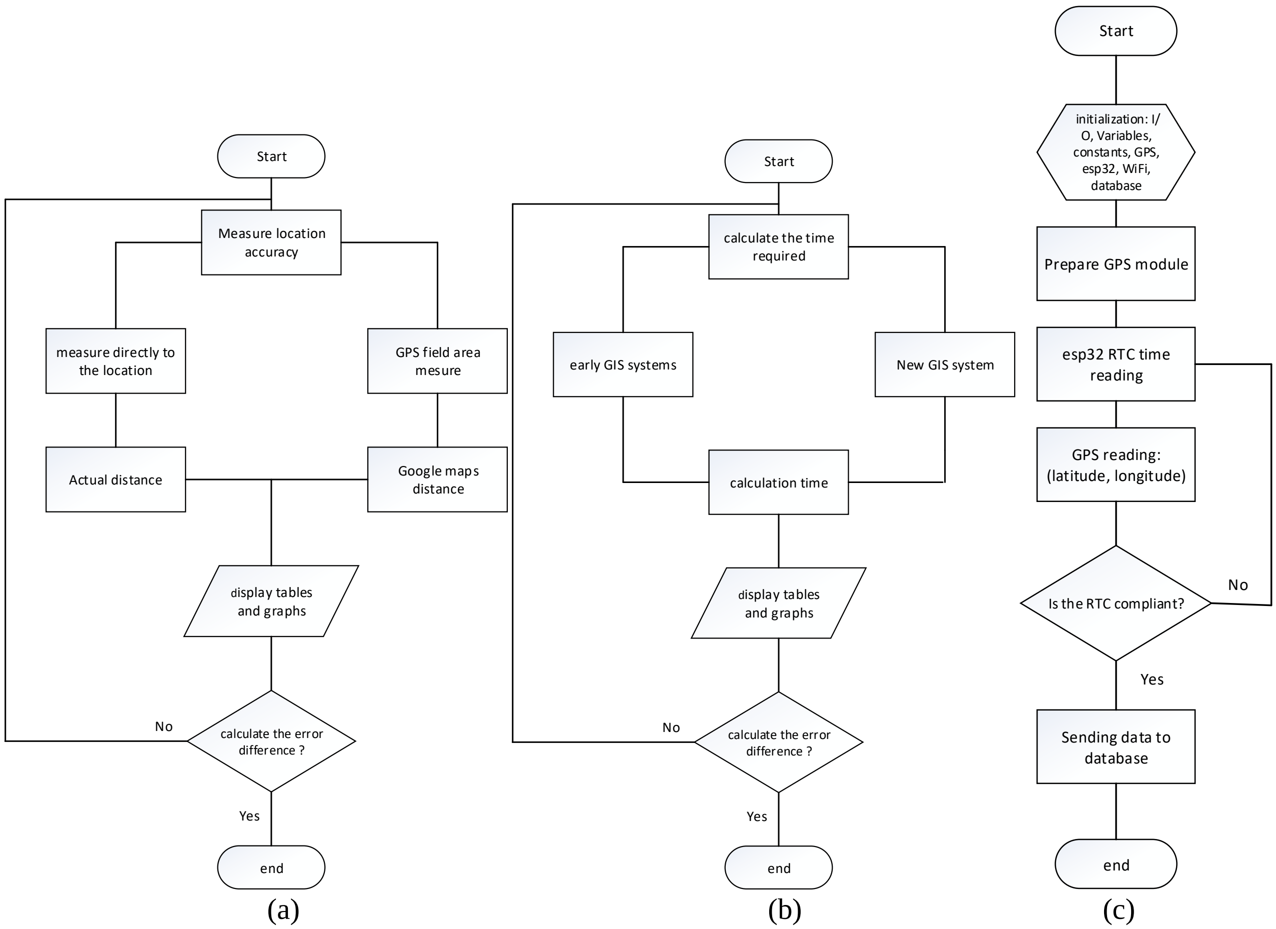


Figure 4. Flowchart Testing of System; (a). location accuracy rate, (b). travel time to the ODP location, (c). process sending data to the server

According to Figure 4, there are three main development stages for this detection system, namely determining the accuracy of the location of the device, the travel time needed to determine the location of the device, and the process of sending sensor data placed on each ODP device to the network server.

4.1. Testing of System

In this research, system testing was carried out according to the parameter indicators to be measured, namely location accuracy through the GIS method, travel time to the device location via the GPG sensor, and sending data to the server. The shape of the ODP device placement that has been designed and developed directly on-site can be shown in Figure 5. Each of these devices has added a GPS sensor component and a microcontroller as a data processor which will later be used by GIS to measure these three parameters.

Figure 5. The ODP Device Placement

a. ODP location accuracy measurement

The flow of methods and steps for accurately measuring ODP location points in research is carried out to provide convenience in analyzing the results which will later be compared with the previous system where the algorithm steps and results of the test data can be seen in Figure 6 and Table 1.

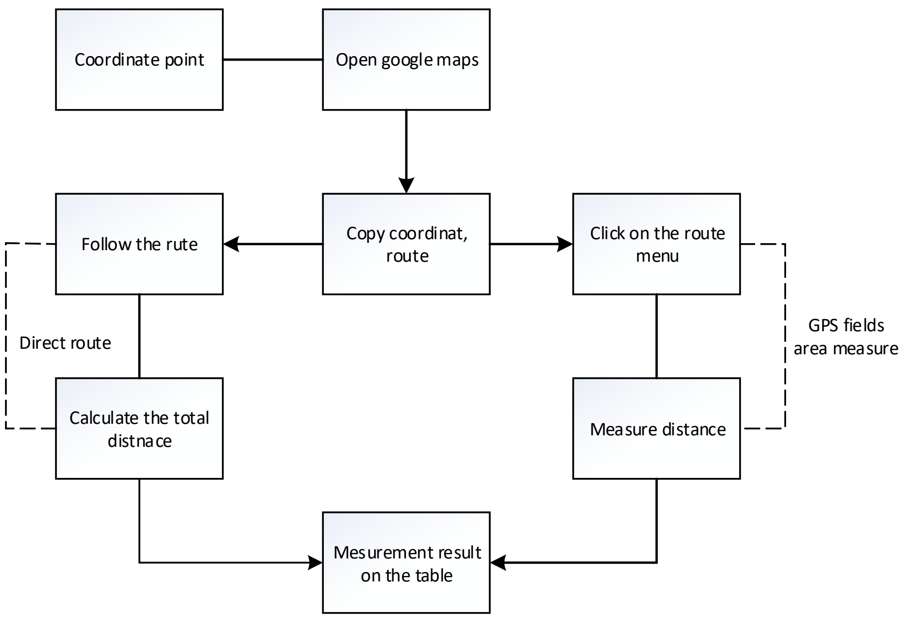


Figure 6. Calculate the location point of ODP through the GIS approach

For test results in determining the location of ODP accurately shown in the system test table after being developed through the GIS approach (table 1).

Table 1. Results of testing the location of the ODP device after development

Name ODP	**Coordinate point**		**Distance (Km)**				**Average *Google maps***	**Percentage of error**
	Latitude	***Longitude***	**Real**	***Google maps***				
ODP-LBG-FFF/003	-6.927641891	107.66382863	8,30	8,32	8,32	8,30	8,31	0,12%
ODP-LBG-FFF/004	-6.927623204	107.66326808	8,40	8,40	8,39	8,40	8,39	0,11%
ODP-LBG-FFF/005	-6.927630178	107.66346193	8,40	8,40	8,41	8,40	8,403	0,03%
ODP-BDK-FAF/059	-6.9619203429632	107.56500361861	11,00	10,96	10,98	11,00	10,98	0,18%
ODP-BDK-FAF/066	-6.9611864862745	107.56521607017	11,00	11,02	11,09	11,00	11,03	0,27%
ODP-BDK-FAF/061	-6.9609098593062	107.56507162107	11,10	11,11	11,10	11,10	11,103	0,02%
ODP-BDK-FAF/062	-6.9614065181876	107.56537606012	11,10	11,08	11,10	11,09	11,09	0,09%
ODP-CJA-FEW/017	-7.0002826440547	107.64546742541	12,90	12,91	12,91	12,9	12,90	0,04%
ODP-CJA-FEW/043	-7.0002870247901	107.64158104399	12,60	12,59	12,58	12,59	12,58	0,11%
ODP-CJA-FEW/018	-6.9999351354289	107.64531758642	12,90	12,90	12,89	12,90	12,89	0,03%
the total number of errors from each location point test								1,00%

The total error value related to the detection results of ODP location points is obtained from the sum of each detection error for each ODP that is the search target. The detection error value for each ODP trial can be calculated based on equation 1. Meanwhile, in general, the total system error value is the accumulated sum of each trial using Equation 2.

$$Error\ percentage\ (e_{n-th}) = \frac{|actual\ distance - average\ distance|}{|actual\ distance|}\ x\ 100\ \% \quad (1)$$

$$\sum_{i=1}^{n} e_{tot} = e_1 + e_2 + \cdots + e_n \quad (2)$$

b. Travel time measurement

This measurement is carried out to determine and measure the efficiency of a technician's travel time in determining and identifying ODP location points, starting when the technician receives notification of ODP location data in the field sent from the central database. The simple travel time algorithm is shown in Figure 7.

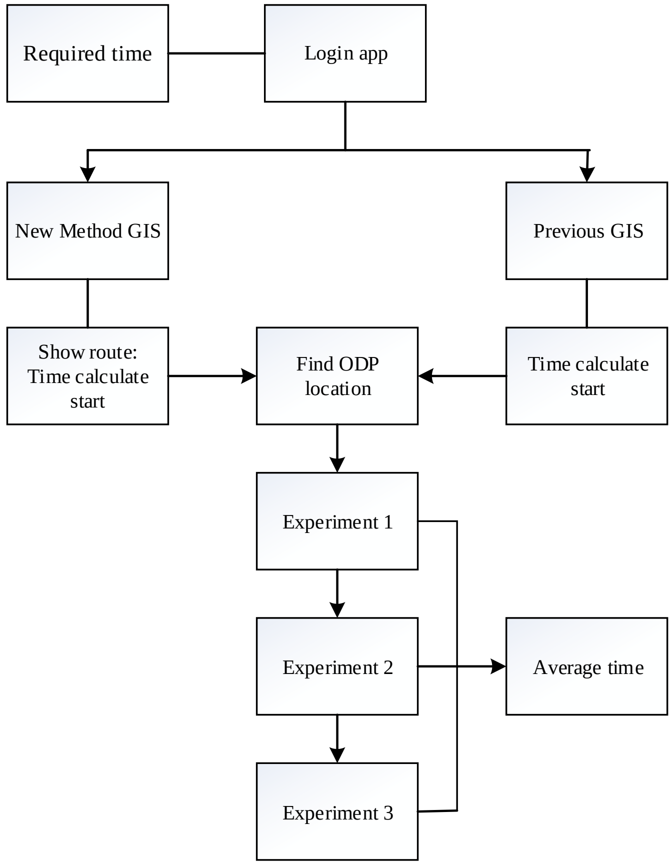


Figure 7. Travel time algorithm to ODP location point

The results of testing the time needed for a technician to find the ODP location point accurately can be seen in Tables 2 and 3 which show the average travel time before and after the system is developed.

Table 2. Results of the travel time test to the ODP location (previous GIS)

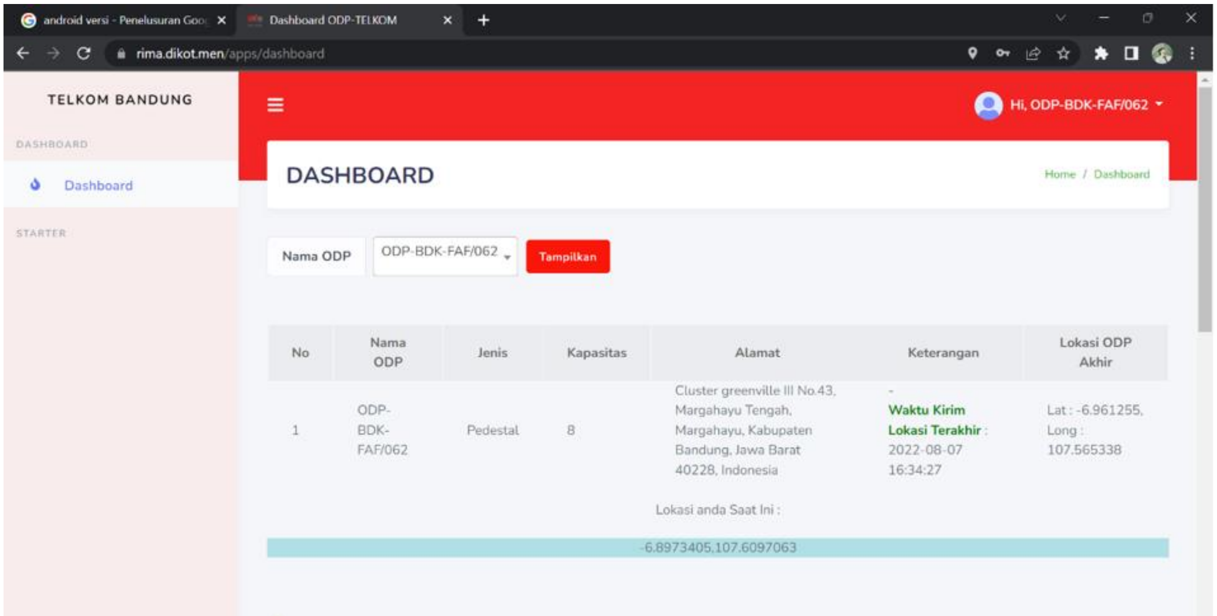
Location point	Distance (Km)	Time required			Time average
		experiment-1	experiment-2	experiment-3	
ODP-BDK-FAF/066	11	36 minute 58 sec	37 minute 42 sec	34 minute 08 sec	35 minute 16 sec
ODP-BDK-FAF/061	11,1	39 minute 06 sec	39 minute 13 sec	38 minute 31sec	38 minute 56 sec

Table 3. Results of the travel time test to the ODP location (new GIS)

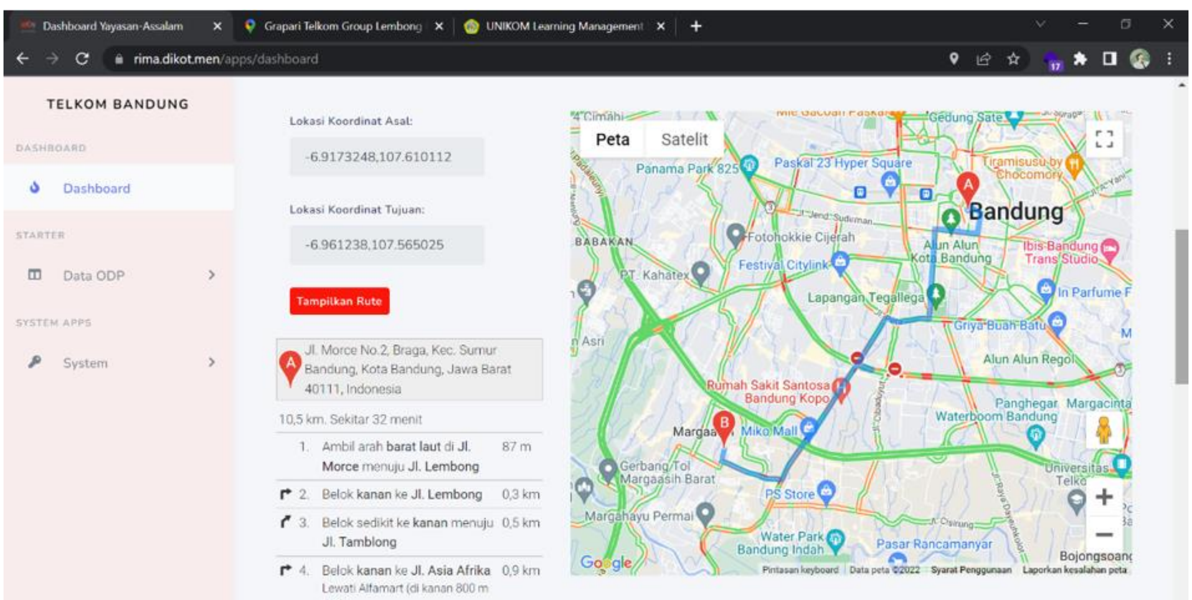
Location point	Distance (Km)	Time required			Time average
		experiment-1	experiment-2	experiment-3	
ODP-BDK-FAF/066	11	30 minute 41 sec	31 minute 21 sec	30 minute 18 sec	30 minute 46 sec
ODP-BDK-FAF/061	11,1	32 minute 04 sec	32 minute 56 sec	31 minute 45 sec	32 minute 14 sec

c. Testing process of sending data

This test is carried out to show the results of system development that has been designed through the addition of the GIS method. The results of the dashboard display of the detection system development application are shown in Figure 8.



(a)



(b)

Figure 8. Display of sending data process; (a). at the dashboard, (b). google maps

5. Conclusion

The system device developed can integrate Google Maps by displaying Optical Distribution Point (ODP) location information properly. Test results for the location point on ODP-LBG-FFF/003 with a direct measurement distance of 8.3 km and measurements using a GPS field measure sensor with 3 trials obtained a distance of 8.31 km. Location accuracy point testing has a smaller error value of 1% compared to the error from the previous system, which was above 3.6%. It is hoped that the impact of the results of this research in the future will be able to contribute to optical-based internet network service companies in identifying ODP location points quickly and accurately and be able to increase travel time in searching for ODP locations.

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