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RESEARCH ARTICLE

Analysis of Distance and Travel Time Calculations in the Implementation of Non-Directional Beacon Courses

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ABSTRACT

This research aims to determine the design of an Android-based distance and travel time information media simulation that is capable of providing location information regarding the location of airport service facilities by implementing the working system of a navigation tool, namely Non-Directional Beacon. The subject of this research is the area of the terminal, which will be included in the application, while the research object is the location of airport public service facilities that have been provided by the airport management. The research procedure used is adapting the research and development (R&D) method to the ADDIE method approach. The data source is reference distance information on the Map application, the Auto CAD application, and the Mapplic application. The type of data is quantitative data (direct measurements in the relevant field). The instruments used in data collection are the mapplic application and the auto CAD application. The data collection technique was carried out using trials and questionnaires. The data analysis technique used is black box testing. The results of this research found a linear regression equation, namely $Y = 75.531_X + 41.229$, with an R^2 value of 0.9941. For sample 1, the length of travel time required, namely by comparing the map distance of 278.787, the travel time based on the actual distance is 82.52, so to calculate the travel time required for the distance 82.52, namely $82.52 - 41.229 = 41.291/75.531 = 0.5466$ or 0.55 minutes (with rounding). while the travel time for sample II with a map distance of 732 pixels and the actual distance is 732 pixels $\times$ 0.296 meters = 216,672 meters, then the travel time required is 216,672 meters − 41,229 = 175,443/75,531 = 2.3227 or 2.32 minute. From these calculations, it is compared with the results of the time and distance obtained based on the application developed, namely the design of the directional path in the terminal by first determining the origin coordinate point and destination coordinate point in the application developed.

Keywords: Distance and time, Information media, Mapplic, Non-directional beacon.

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1. Introduction

Transportation Travel as Indonesia's eastern gateway in serving the movement of passengers and goods is better known as Sultan Hasanuddin Makassar International Airport [1], [2] and as the starting or ending point for the movement of people/goods as aviation network nodes [3]. The increase in the number of aviation service users is accompanied by the development of airports with large capacities so that they are able to serve aviation activities in the long term, and the quality of the services provided to aviation service users is very important to improve [4].

The supporting facilities needed by passengers while carrying out activities at the airport, both at the arrival terminal and at the departure terminal, have been presented in the form of information in the form of direction signs, and even at several large airports, information boards have been installed at certain points containing the layout of the airport, its availability. Signs at airport terminals refer to Minister of Transportation Regulation Number KM.22

of 2005 concerning the implementation of SNI 03-7094-2005 regarding signs at airport terminals as a mandatory standard.

Observation results [5], related to the use of technology when flight service users utilize public service facilities in the terminal, where the social factor (Y) was obtained from the results of a questionnaire distributed to passengers who were going to the departure terminal waiting room and those who were While in the departure waiting room, it is known that the respondent's response to Y_1 is the level of knowledge of passengers to use a positioning application using GPS by 30%, in the terminal 70%, Y_4 passenger ability to adapt to technology is 98%.

On the other hand, it was found that several passengers who were about to take a flight or who had landed at the airport and would continue their journey using land transportation experienced delays caused by departure delays or the passengers' own time management, so that in utilizing the limited time, service was needed. Additionally to make it easier for passengers to find the location they need while in the airport terminal. An important point in the feasibility of a passenger terminal is the ease of accessibility and comfort of passenger movement.

This research offers several benefits that can be enjoyed by flight service users and makes it easier for airport managers to provide information services to passengers, minimizes time searching for the location of facilities needed by passengers, provides space for passengers to utilize waiting time for baggage, reduces the accumulation of passengers at one point., assists passengers in providing alternative choices in utilizing airport facilities, provides information on the distance and time required for passengers to get to the required airport facilities, and can be monitored via the passenger's own smartphone screen or Android cellphone.

This information system design can be used by utilizing smartphone technology devices, where the information system for directing the location of aviation service users to the location of public service facilities at the airport terminal is designed using the Mapplic application with regression calculations so that the information system in the form of this application can provide accurate route information can be taken to the location of the required facilities, information on the required travel time and information on the real distance required from the location of the flight service user to the location of the public service facilities at the airport terminal.

2. Background

The area of Sultan Hasanuddin Makassar International Airport is 53,045 m^2 [6] with the number of flights increasing under normal conditions, the average daily user of domestic and international flight services over the last 5 (five) years, namely in 2016 was 29,880 people/day, in 2017 it was 34,151 people/day, in 2018 as many as 37,605 people/day, in 2019 as many as 29,881 people/day and in 2020 as many as 16,936 people per/day and data on the number of flight service users transiting at Sultan Hasanuddin International Airport as shown in Fig. 1.

Based on Fig. 1 above, it appears that the number of transit passengers is still dominated by domestic flights, and referring to research conducted by [5] that the ability of passengers to adapt to technology is 98%. Technology that can be developed to meet the needs of aviation service users regarding the availability of airport service facilities in terminals or waiting areas, arrival areas, and departure areas is by applying the principles of Non-Directional Beacon (NDB) equipment, namely devices used in flight navigation to assist The pilot determines the position of the aircraft in relation to the location of the ground station which transmits the location signal for the location of the airport by referring to the direction of the earth's magnetic north. The value of the electric field strength produced by a Non-Directional Beacon (NDB) beacon is a function of important parameters, including distance, frequency, ground conductivity, and isotropic effective radiated power (EIRP) [7]. Non-directional beacons are low or medium-frequency radio beacons that operate in the frequency range of 190 to 1,750 kilohertz (kHz). The radio beacon used in conjunction with the Instrument Landing System marker is called a Compass Finder [8].

The working principle of NDB is based on the concept of measuring direction from radio signals received by the aircraft, and this helps the pilot in navigating the aircraft he is responsible for during the flight, especially in bad weather conditions or when precision navigation is required. NDB generates radio signals on special frequencies that can be heard by aircraft equipped with NDB receivers. The frequency used is usually in the MF (Medium Frequency) range, with the direction of the NDB beam being omni-directional. The Morse Code Identifier is a series of dots and short lines emitted in the form of a Morse code that is unique for each NDB station, Aircraft Direction Indication equipped with an NDB receiver can determine the direction relative to the NDB using a navigation instrument called ADF (Automatic Direction Finder). Limited to Distance: One of the disadvantages of NDB is that its signal can be affected by weather factors such as storms and electromagnetic interference. Apart from that, NDB also has a limited range, so it can only be used within relatively close distances to NDB stations. NDB is used in aviation navigation to determine the direction and position of an aircraft, especially in situations when modern navigation systems such as GPS are not available or as a backup if modern equipment is damaged or disrupted.

By applying the principles of NDB devices in designing Android-based distance and travel time information media simulations also utilize modern navigation technology such as GPS, which has replaced most of the need for NDB in commercial flights. However, NDB is still used in some situations, especially in remote areas or in special flight operations. However, GPS is effective for use outside buildings, while inside buildings, especially airport terminals, it is effective to use beacons that are not disturbed by obstacles.

3. Methodology

The research procedure used is to adapt the Research and Development (R&D) development model to the

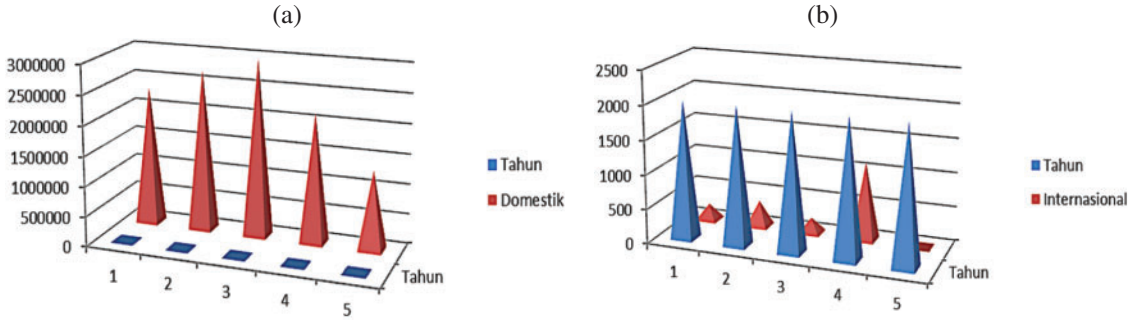

Fig. 1. Graph of the number of movements of aviation service users: (a) Domestic flights and (b) International flights.

ADDIE method approach with 5 (five) stages, namely: Analysis, Design, Development, Implementation, and Evaluation. The subject of this research is the area of a terminal that will be input into the application, while the research object is the location of airport public service facilities that have been provided by the management of Sultan Hasanuddin Makassar International Airport. The data source is the results of measuring the distance of the facility location at the Sultan Hasanuddin Makassar International airport, the plan of the Hasanuddin Airport Terminal in the form of an Auto CAD application for canvas width and indoor width using the Mapplic application. The type of data is quantitative data (direct measurements in the field). The instruments used in data collection were questionnaires and measurement sheets. Data collection techniques were carried out using field observations, interviews and questionnaires. The data analysis technique used is to carry out linear regression testing.

4. Results

In aviation radio navigation using the NDB/ADF system, the main role is played by radio stations-Non-Directional Beacons (NDB). NDB transmitters have antennas that transmit radio signals non-directionally but symmetrically on all sides. The NDB itself does not produce a radial shot of information to these navigation points, as is the case with the VOR/DME Beacon [9]. The pilot's navigation information is the heading angle to the radio station (Bearing). The on-board Auto Direction Finder generates this bearing information (ADF). It uses the concept of non-directional – circular radiation from the wave front, which always exists perpendicular to the radiation source—the NDB antenna whatever point in the vicinity of the NDB transmitter [10].

The basic principle of a beacon device, especially in an aviation context, is to provide a reference or point of reference that can be identified by the receiver at a specific location, have a transmitter that produces a recognizable signal or sign, the beacon has a frequency or type of signal that must be tuned to detect the signal specific beacon while the receiving device is set to detect signals from the corresponding beacon. This receiver can be navigation equipment or a device that can interpret beacon signals according to navigation or marking purposes. Non-Directional Beacon (NDB) equipment to determine direction or location relative to the NDB station. The receiver on the aircraft will measure the direction from the aircraft to the NDB and use it to determine relative position. Beacons are used in various applications, including aviation navigation, maritime navigation, marking in emergency operations, marking in certain environments such as marking in the terminal area as a check point for the initial position, namely the location point where the aviation service user is when using this application and the position they will go to in This is the location of airport service facilities required by aviation service users which is designed as a direction guide that also displays the distance and travel time to the desired facility [11].

The average use of airport services is for various age groups and professional fields, so it can be concluded that the use of air transportation modes is comprehensive both in terms of age and field of work. This is proven by the absence of a significant increase in the value between the age factor and the professional factor in the use of services at airports, especially at Sultan Hasanuddin Makassar International Airport, as shown in Fig. 2.

This research focuses more on the terminal area on floors I and Floor II, which are the departure terminal area (Check-in area and departure lounge area) as well as the arrival terminal (baggage claim area and plane transfer or transit area) because it is based on the results of a summary of interviews with service users flights, in this area passengers spend more time using air transportation.

The image above shows the plan and flow of passenger movement while in the terminal, especially departure and arrival access, while access to the waiting or boarding area is shown in Fig. 4.

Based on Figs. 3 and 4, the terminal design data uses a scale of 1:1100, so it cannot be ascertained in detail the distance to each facility location. To find out the exact distance to each location using data from the AutoCAD application, the Google Map application was chosen as a comparison with walking activities, as shown in Fig. 5.

From Fig. 5, data is obtained from the Google Map application for human movement or aviation service users. If moving on foot at a distance of 120 meters takes 1 minute, so to find out the value of 1 pixel from an Auto-CAD image, you can use the mapplic-routes application by measuring The indoor terminal width as shown in Fig. 6, where reference information is obtained for calculating the indoor terminal width via the mapplic-routes application of 380.73 meters as a comparison of the canvas width from the Auto CAD application with a scale of 1:100, namely 1282 Pax. With the following description: The indoor

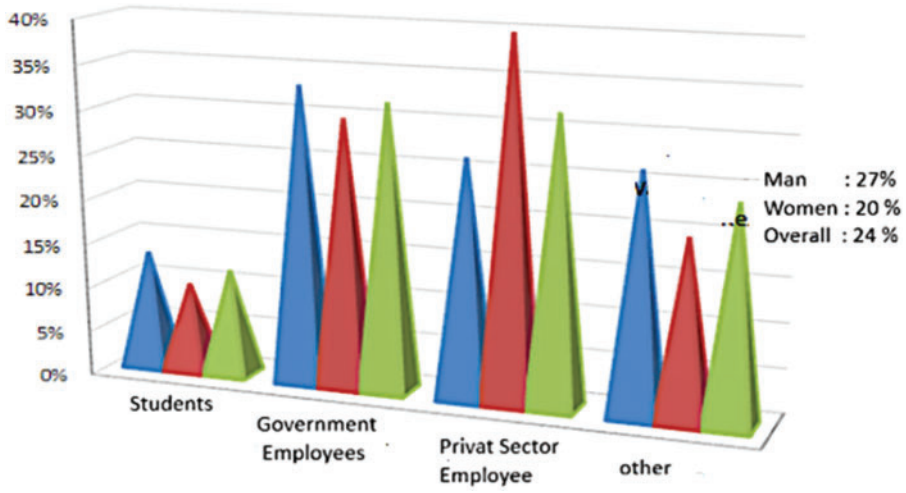

Fig. 2. Graphic of professions/occupations of aviation service users.

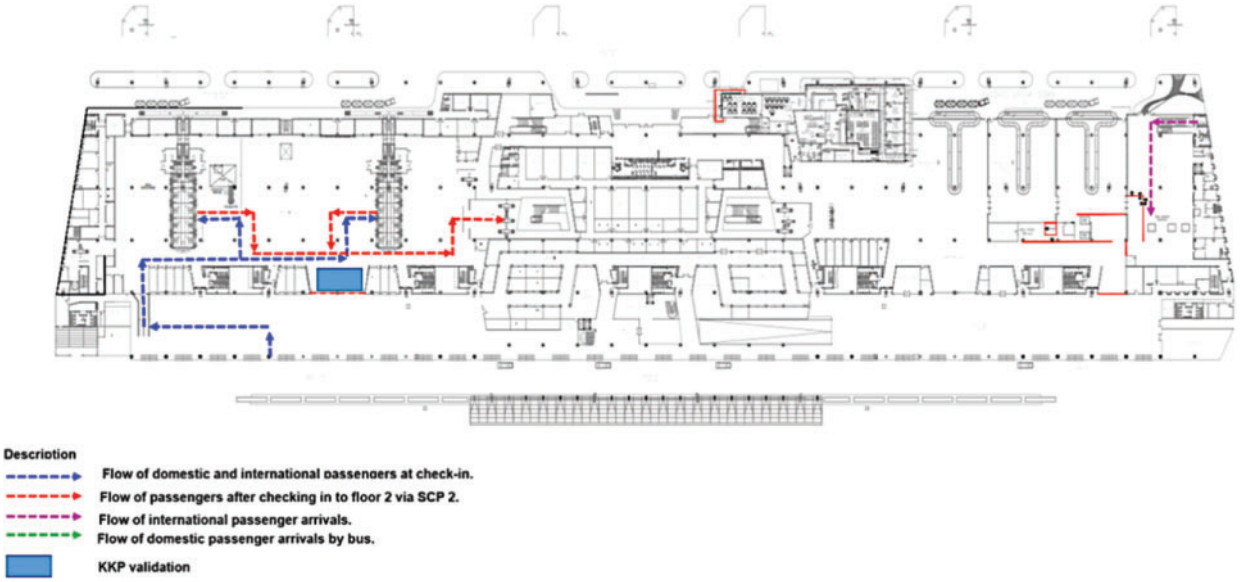

Fig. 3. 1st floor passenger flow.

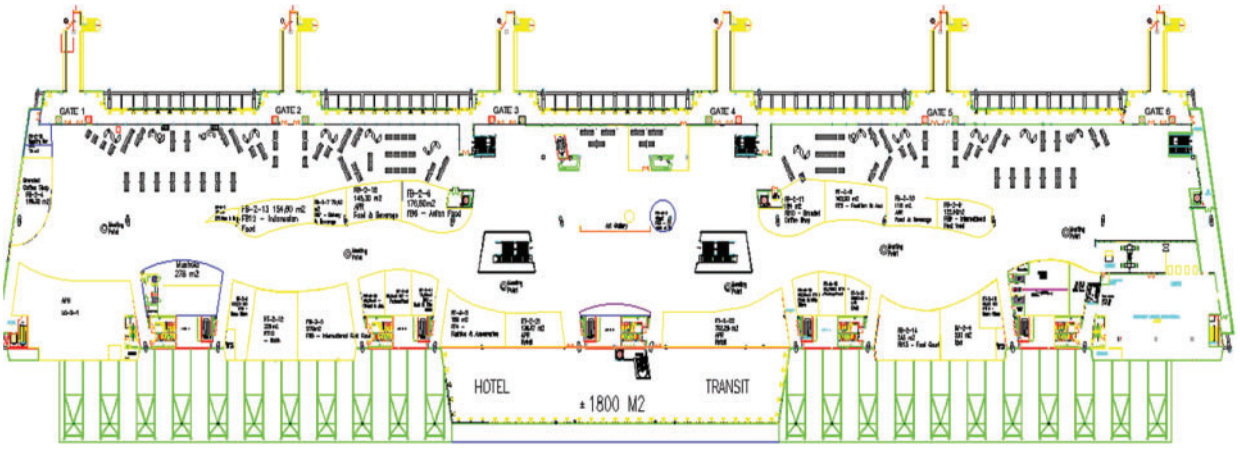

Fig. 4. Plan of the 2nd-floor terminal.

width via the route map application is 380.73 meters, while the Canvas width via the 1:1100 scale AutoCAD application is 1282 Pax. So, the ratio of Mapplic and AutoCAD is 380.73 meters divided by 1282 Pax, which is 0.296 meters or 0.30 meters (with rounding). So, it can be concluded that 1 pixel is 0.30 meters.

Fig. 6 shows the results of distance calculations using the mapplic-routes application with several coordinate points traversed from the origin to the destination point.

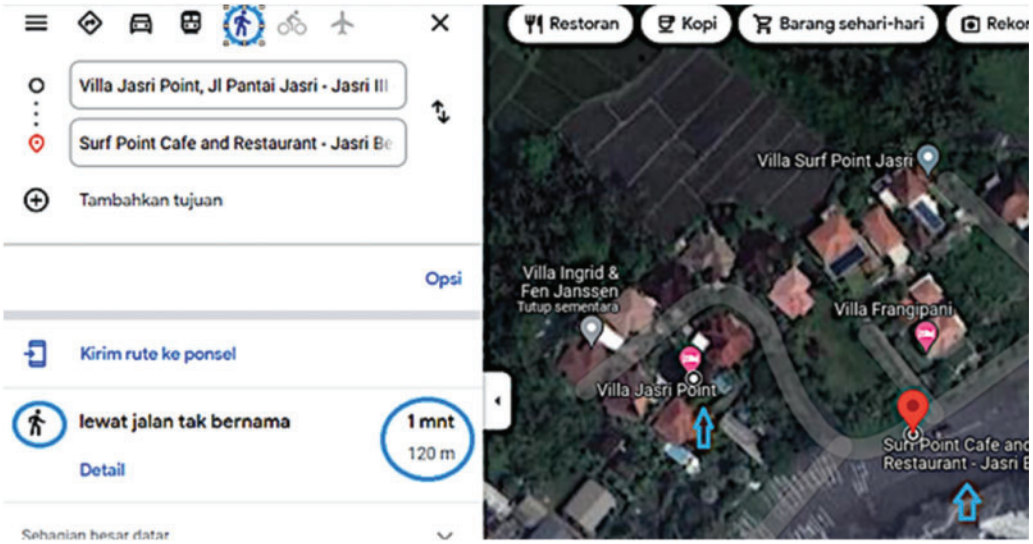

Fig. 5. Google Map application as a comparison reference for AutoCAD drawings.

For sample I, a trial measurement was carried out using the mapplic-routes application of 278.78700279714917 with rounding of 278 pixels, the map distance which can be proven by the Linear Regression calculation (Fig. 7).

After verifying the reading coordinates of the mapplic-routes application using linear regression calculations, you can find out the travel distance and travel time on a scale of 0.3 as a comparison between the indoor width and the canvas width. Based on these data, the actual distance for Sample distance I is the map distance x comparison scale with a value of 278,787 pixels multiplied by 0.296 meters equals 82.52 meters.

Meanwhile, measuring the travel time required for a distance of 82.52 meters can be calculated using the Linear Regression formula (google map-walking data sample). To calculate the linear regression value, refer to the results of the coordinates displayed in the mapplic-routes application, which can be seen in detail in Fig. 7. To determine the comparison of distance and time with linear regression, the step taken is to enter the variable values for minutes and distance by referring to the google application, Map, namely, 1 minute can be traveled by walking 120 meters. Using this comparison and then using the Excel application to connect the distance and time variables with linear regression, the linear regression equation can be seen in Fig. 8.

Based on Fig. 8, the results of the linear regression equation are $Y = 75.531x + 41.229$ with an R^2 value of 0.9941. For sample 1, the length of travel time required, namely by comparing the map distance of 278.787, the travel time based on the actual distance is 82.52, so to calculate the travel time required for the distance 82.52, namely $82.52 - 41.229 = 41.291/75.531 = 0.5466$ or 0.55 minutes (with rounding). while the travel time for sample II with a map distance of 732 pixels and the actual distance is 732 pixels × 0.296 meters = 216,672 meters, then the travel time required is 216,672 meters − 41,229 = 175,443/75,531 = 2.3227 or 2.32 minutes. These calculations it is compared with the results of the time and distance obtained based on the application developed, namely the design of the directional path in the terminal by first determining the origin coordinate point and destination coordinate point in the application developed.

5. Discussion

Based on the results of interviews with flight service users, it was still found that some flight service users/passengers did not understand the location of the facilities they needed while in the terminal, flight service users still often experienced problems finding airport information boards or directions according to the needs of flight service users., the availability of officers is still limited to certain times in the terminal and is easily found by flight service users, the increase in the number of passengers based on flight data for the last 5 (five) years before the pandemic, and passenger density in the terminal area cannot be avoided so by looking at this condition, Flight service users need more time to carry out their activities.

Supporting facilities in providing information needed by passengers while carrying out activities at the airport, both at the arrival terminal and at the departure terminal, are available in the form of directions, and even at several large airports, information boards have been installed at certain points containing a floor plan of the airport, this condition It still makes it difficult for aviation service users to find the location of the facilities they need because it still takes time to find the information board and potentially find a sign pointing to the location of the required facility further from the initial location where the aviation service user is located.

From the summary of interviews regarding the service needs of aviation service users while in the terminal, it can be concluded that aviation service users need fast and precise information services to meet their needs while in the airport terminal and referring to the results of the 2017 ICT user survey shows that 66.3% of individuals have a smartphone out of 6246 respondents and 33.69% of individuals do not have a smartphone. According to a study by MobiLens [12], the number of mobile app users in the US grew by 28% between April 2009 and April 2010.

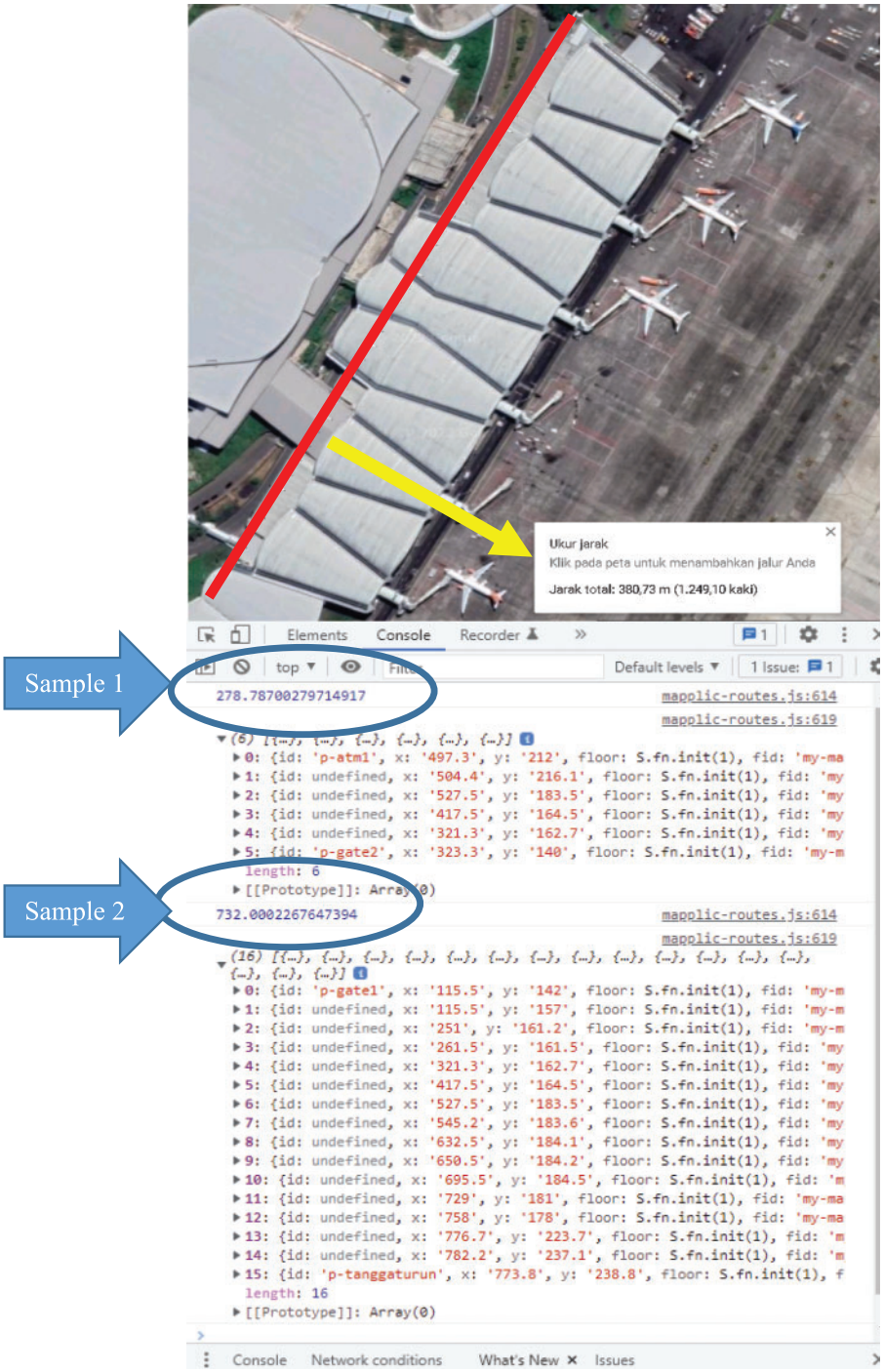

Fig. 6. Measurement of the indoor width of the terminal using the mapplic-routes application.

The development of the application design is a refinement of the information services currently available at Sultan Hasanuddin Makassar International Airport in the form of direction boards installed at several points, while the information services currently available at Soekarno Hatta Jakarta International Airport are in addition to direction information boards. It has also been equipped with several monitor screens or *way finding* screens with a digitalization system which provides information on the direction to the location required by flight service users at the departure terminal.

The two information services provided by Sultan Hasanuddin International Airport and Soekarno Hatta International Airport, aviation service users still need time to find the information boards, whether they are still in the form of directional arrows or have implemented a digitalization system because the availability of way finding monitor screens is still limited. at several points and for the process of adding additional waysfinding installations, taking into account the size of the terminal area and will continue to expand due to increasing public interest in

TABLE I: Calculations for Sample Tests I and II

Sample	Distance map	Actual distance	Traveling time
1	278 Pixels	82.56079563	0.55 minutes
2	732 Pixels	217.3902964	2.33 minutes

Note: (Source: Results of Research Data Processing).

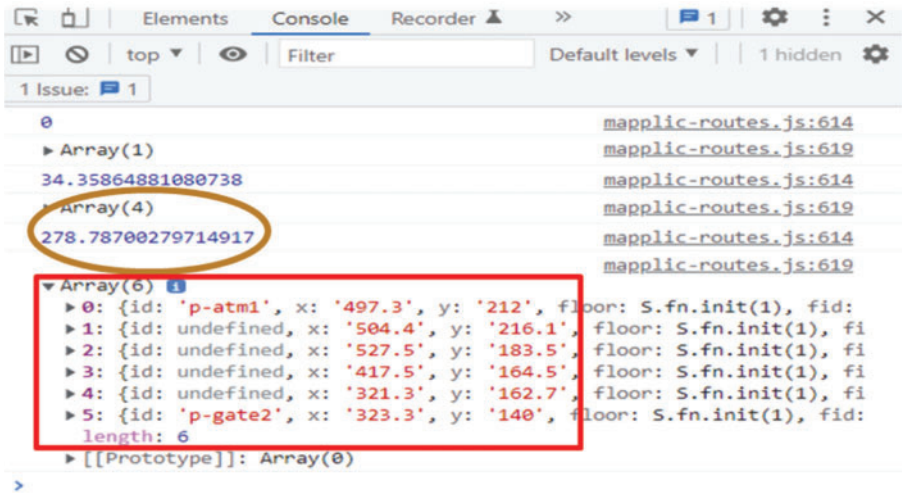

Fig. 7. Conversion of coordinate point values to linear regression with application mapplic.

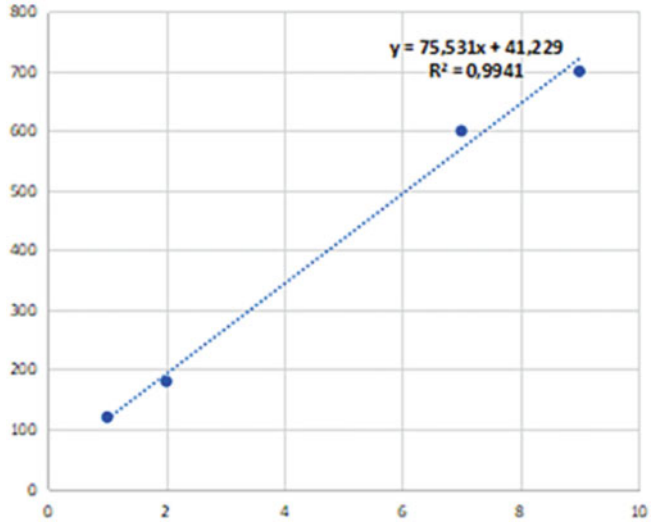

Fig. 8. Sample foot trip route data using google maps.

using air transportation modes, which can be categorized as providing services with the fastest distance compared to other modes of transportation and prioritizing safety, security, and comfort in providing services to aviation service users. To implement the development of an Android-based distance and travel time information media simulation design, it is able to reduce the cost of procuring way finding devices such as those available at Soekarno Hatta Airport because this development utilizes smartphone devices owned by each flight service user.

The development of a simulation design for Android-based distance and travel time information media is used online or utilizing the internet network where the internet network has previously been provided by all airport managers in Indonesia, especially at Sultan Hasanuddin Airport in Makassar which has been recommended by the Directorate General of Civil Aviation as an airport. International Air, specifically for the eastern region of Indonesia. Based on reading the coordinates of the map plic route application using linear regression calculations, as shown in Table I to be able to find out the travel distance and travel time with a scale of 0.3 as a comparison between the indoor width and the canvas width, then if the distance on the map is 278 pixels equals 82.52 meters actual distance or travel time 0.55 minutes on foot.

6. Conclusion

Design of distance and travel time information media in the form of directions that can be connected to *a smartphone* as a medium to support the services required by aviation service users. The management of Sultan Hasanuddin Makassar Airport needs a supporting application that can be developed, namely the mapplic application, which is used in designing the application. This mobile direction guide is done by first drawing/re-designing the location of the facility according to the image on the terminal plan by referring to the terminal AutoCAD application image, then determining the coordinate points of each location so that in selecting the required route, it is done by selecting the origin coordinate point and the destination coordinate point. to be able to display a map showing directions to the location of the required facilities, travel time, and distance traveled by flight service users to the location of the required facilities.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

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