Analytical Hierarchy Process Algorithm for Traffic Sign Improvement Priority

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***Abstract* - Traffic signs are part of road equipment that is very important for motorists because they can provide direction while on the highway, and if there is damage, repair or replacement must be carried out immediately because it can cause traffic accidents. Data collection for damaged traffic signs is still done using the manual method, so it takes a long time. Therefore, a web- and android-based application was designed that implements the Analytical Hierarchy Process (AHP) algorithm in determining the priority of repair or replacement of traffic signs on the route of South Sulawesi Province. As a result of this research, the public can report the type of damage and its location via Android, and then the officer processes the data so that it displays the type of damage that is a priority for repair or replacement. Implement the Analytical Hierarchy Process algorithm into the application for prioritization of traffic sign improvement using two (two) web-based and Android platforms. System design using UML produces use cases (2 actors, admin, and user) and class diagrams (15 admin classes and 4 user classes). The black box used as a test produced 40 modules, of which all were in line with expectations.**

Keywords: Traffic Signs, AHP, priority, web, android

I. INTRODUCTION

Traffic signs are part of road equipment that contains symbols, letters, numbers, sentences and/or a combination of them, which are used to provide warnings, prohibitions, commands and instructions for road users [1][2]. Traffic signs are very important for drivers because they can give directions to drivers while on the road, and if there is damage to traffic signs, repairs or replacements must be carried out immediately because they can cause traffic accidents[3][4].

The Transportation Agency (Dishub) of South Sulawesi Province is a government agency responsible for repairing or replacing existing traffic signs on provincial roads [5] by monitoring and recording all damaged traffic signs that will be submitted to the traffic department for repair or replacement of traffic signs. Survey data or the results of processing traffic sign data on the South Sulawesi Province route are carried out manually, namely in written format. This is difficult to inventory as a whole because officers have to monitor every year so it takes a long time while the need for sign repairs must be done as soon as possible so as not to harm road users, the location of the traffic signs in the data is difficult to find because there is no information about the coordinate points, and there is no evidence of the type of damage in the form of photos so it is difficult to determine the necessary traffic signs prioritized for immediate corrective or replacement action, From this presentation, problems were formulated, namely: how can the community report damage to traffic signs on the South Sulawesi Province route and how to manage traffic sign damage report data that needs to be prioritized to be repaired or replaced so that the purpose of the study is to design an android-based traffic sign damage reporting application and implement the Analytical Hierarchy Process (AHP) algorithm to process and View priority reports on repairs or replacement of traffic signs.

Similar research has been conducted by several researchers including Yusuf Ramadhan Nasution with the title of determining the level of traffic congestion with the Analytical Hierarchy Process (AHP) method, the weakness of this study cannot display data on traffic signs that have been damaged [6]. Furthermore, by Desi et al, with the title Utilization of WebGIS for Mapping the Location and Conditions of Banjarbaru City Traffic Signs [7] and Fajaruddin et al with the title of application for complaints of damage to traffic signs at the SIAK district transportation office [8] the 2nd weakness of this study, does not inform the type of damage to traffic signs and does not apply methods to prioritize which signs should be repaired immediately. Next, research entitled the application of the Analytical Hierarchy Process (AHP) algorithm to determine traffic enforcement patterns by Roni Anagora, et al [9]. The problem of this research, the lack of police personnel in DKI Jakarta which results in less supervision and enforcement and can only conduct raids at any time, by designing a traffic control system using the Analytical Hierarchy Process (AHP) method and Decision Tree for supervision and enforcement of traffic violations, is expected to help reduce the placement of police members at red lights. Furthermore, research entitled Decision Support System for Prioritizing Road Repair Using AHP-TOPSIS Method by Firdau Rahman, et al [10]. The conclusion of this study using the AHP-TOPSIS method for road repairs was obtained the highest accuracy value of 49.31% and the lowest accuracy value of 32.87%. The low level of accuracy of the system is caused by road repairs in the field, there are still several individual interests so that there are still inaccurate targets in handling existing roads. Next, research entitled Determination of the type of traffic operation action based on the level of traffic vulnerability using the Analytic Hierarchy Process method and Visualization of Mapping in the Jepara Regency Area by Ayu et al [11]. The types of actions in Jepara district are counseling, patrols, and raids. In deciding the type of action in an area, only based on observations from superiors, so that in its implementation it may still be inaccurate in the aspect of priority of the type of action taken. The result of this study is the calculation of AHP in the form of a priority sequence of actions. The data needed in calculating AHP are the age of violators under 17 years, the age of violators 17 years and over, and the total incidence of accidents. Furthermore, the title of the priority research on handling national roads using the AHP and ANP methods by Rahmatsyah et al [12]. The problem of this research is that the limited government budget in managing road pavement conditions causes the government to compile a priority ranking of road sections to be handled. Each decision maker has a different assessment for each factor or criterion that is taken into consideration by the customers. Sidempuan, using the AHP and ANP methods, with criteria of traffic volume, level of road damage, government policies, handling costs, and regional development so as to produce the most influential criteria in road handling. Next, a study entitled Determination of the priority scale of district road handling in Kudus district using the Analytical Hierarchy Process method by Hafit et al [13] In this study the priority scale of road handling is based on budget availability and the value of road financial benefits only. The purpose of this study is to obtain the priority order of road handling in Kudus Regency, using the AHP method with 5 (five) criteria used to determine road handling priorities, namely road damage, mobility, traffic volume, accessibility level, and regional development. Based on the AHP analysis, the level of research results showed that the criteria for road damage obtained the highest weight, which was 45.06%.

Based on several previous studies to be used as a reference in the development of this research, research was sparked by implementing the Analytical Hierarchy Process algorithm in determining the priority of repairing or changing traffic signs. This is what distinguishes it from several previous studies because officers can find out the location of damage based on coordinates and the type of damage based on photos from community reports through the android platform [14], so that reports that enter the web [15] can be used as priority sign data for immediate repair or replacement.

II. METHODS AND DESIGN

A. Implementation of Analytical Hierarchy Process

Prioritization of repair or replacement of traffic signs based on 4 (four) alternatives, namely the type of traffic signs warnings, prohibitions, instructions, or orders [16] [17] and 8 (eight) damage criteria, namely lightly damaged (tilted, loose bolts, reverse traffic sign position), moderately damaged (scribbled, unclear image, bent) or severely damaged (broken, missing) [18].

Table 1. Criterion

Criterion
Disappear
Break
Unclear image
Bent
Scribbled
Reverse traffic sign position
Loose bolt
Crooked

Table 2. Alternative

Alternatif
Commemoration
Prohibition
Command
Instructions

Table 3. Comparison Value

	Comparison Value
9	Absolutely very important from
8	Close to absolute from
7	Very important from
6	Approaching is very important from
5	More important than
4	Approaching is more important than
3	A little more important than
2	Approaching is a little more important than
1	As important as

Calculation between criteria by comparing each criterion with other criteria (Table 1). Each criterion will be compared against all criteria (including the criterion itself). Example: comparison of missing criteria value (left) with unclear image criteria (top) is 4.0000, otherwise image is not clear-> disappear = $\frac{1}{4}$ Result =0,2500.

It then normalizes the matrix by dividing each element of the matrix by a row of sums. Example $\frac{1}{2,1607}$ =0,4628 Likewise with $\frac{0,1667}{2,1607}$ =0,0771 And so on, to get the sum value, which is by adding up all the values in each row, while to get the priority value is by dividing each value on the sum value by the number of existing criteria. Example $\frac{3,0103}{8}$ =0,3763.

The way to calculate the multiplication of criteria values and priority weights is to multiply all existing values for comparison calculations between criteria, with all priority values. Example: 1×0,3763=0,3763 And so on. To get the sum value by summing all the values in each row.

Table 4. Consistency Measure

Consistency Ratio	Sum	Priority	Result
Disappear	4,0084	0,3763	10,6525
Break	2,0781	0,1898	10,9513
Unclear image	1,4063	0,1343	10,4692
Bent	0,9740	0,0998	9,7580
Scribbled	0,6926	0,0787	8,7952
Reverse traffic sign position	0,5424	0,0621	87351
Loose bolt	0,3230	0,0382	8,4466
Crooked	0,1889	0,0207	9,1125
Average			9,6151

In Table 4, the values in the number column are taken from the results of the multiplication of criteria values and priority weights, while the values in the priority column are taken from the matrix normalization results column and priority weights, the values in the result column are obtained by $\frac{jumlah}{prioritas}$ Example: On the first line $\frac{4,0084}{0,3763}$ =10,6525, Likewise with the next lines the same thing is done. To get the average, that is by adding up all the values in the result column then divided by 8 (according to existing criteria). RI value or random index as shown in Table 5 [19].

Table 5. Random index value

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Table 6. Final Results Assessment

N (criterion)	N=8
Final Results (λ max)	9,6151
IR	1,41
CI	0,2307
CR	0,1636

In Table 6, N(Criteria)=8 based on the number of criteria, the final result (Max X) = 9.6151(Table 7), IR = 1.41 (Table 8), CI = 0.2307, CR=0.1636.

Calculation of comparison between alternatives by comparing all alternative tables (Table 2) namely warnings, prohibitions, commands and instructions. The comparison of the value of the warning alternative with the prohibition alternative is 4.0000 in contrast to the ban -> commemoration = $\frac{1}{4}$ =0,2500.

The calculation of priority weights between alternative criteria is missing by dividing each element of the matrix by the sum row. Example $\frac{1}{1,6167}$ =0,6168 Likewise with $\frac{0,2500}{1,1667}$ =0,1546 and so on.

The calculation of the matrix value between alternative missing criteria is by multiplying all values by the minimum priority value in the calculation of priority weights between missing criteria alternatives. Example: 1×0.0638 = 0.0638, and the sum column is obtained from the sum result of each row.

How to generate ranking by taking priority values on alternative calculations (warnings, prohibitions, commands, instructions) and priority values on criteria calculations (Lost, Broken, Unclear Images, Crooked, Scribbled, Inverted traffic sign positions, Detached bolts and Tilts). Then the normalization value is obtained from the result of multiplying the alternative priority value and the priority value of the criterion. After that all the normalized values are added together to get the total result.

From the final result of the calculation of the priority search for traffic sign improvement using the analytical hierarchy process algorithm, Table 7, warning ranking is the first priority because it has the highest total value, namely warning = 0.5642, then the prohibition ranking table which is the second priority with a total value of prohibition = 0.2382, then the command ranking table is the third priority with a total value of command = 0.1278, Then the table ranks clues as the lowest priority with a total value of clues = 0.0697.

Tabel 7. Perangkingan

	Total
Commemoration	0,5642
Prohibition	0,2382
Command	0,1278
Instructions	0,0697

B. Unified Modelling Language (UML) Design

The design tool used in this study is UML to produce 2 diagrams, namely use case and class diagram [20]. The usecase diagram of this study is as follows:

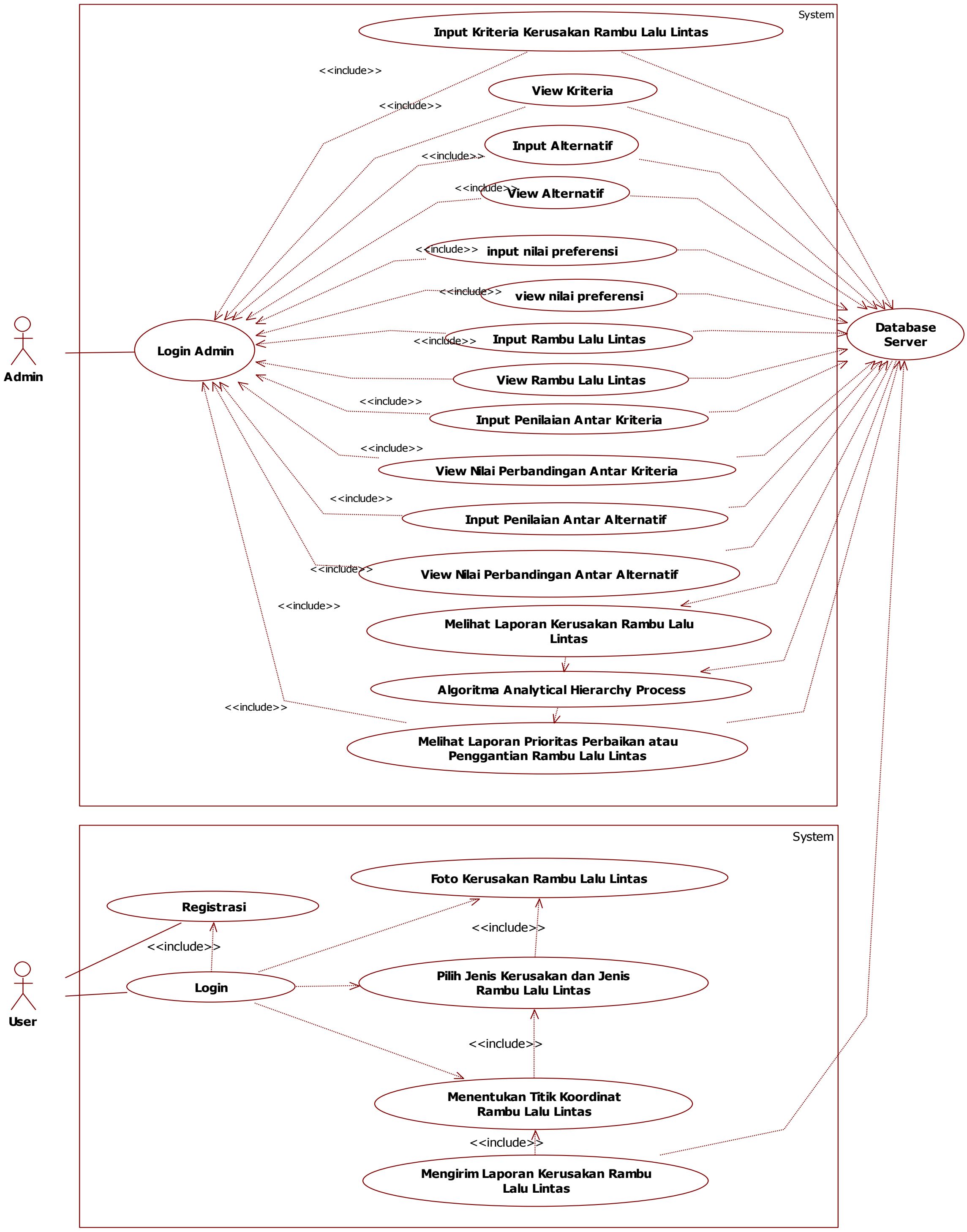

Figure 1. Use Case Diagram

In Figure 1, the use case diagram consists of two actors, namely admin and user. Admin must log in first to be able to input traffic sign damage criteria, view criteria, alternate input, alternate view, input preference value, view preference value, traffic sign input, view traffic signs, input assessment between criteria, view comparison value between criteria, input assessment between alternatives, view comparison value between alternatives, view traffic sign damage reports, View the Improvement Priority report. While the user actor first registers in order to log in to the application, after the user logs in, the user can carry out activities in the application in the form of photos of traffic sign damage, select the type of damage and type of traffic signs, determine coordinates and send damage reports to the database.

UML class diagrams illustrate the classes in a system and their relationships to each other [21]. Here's what the class diagram looks like in the app to build:.

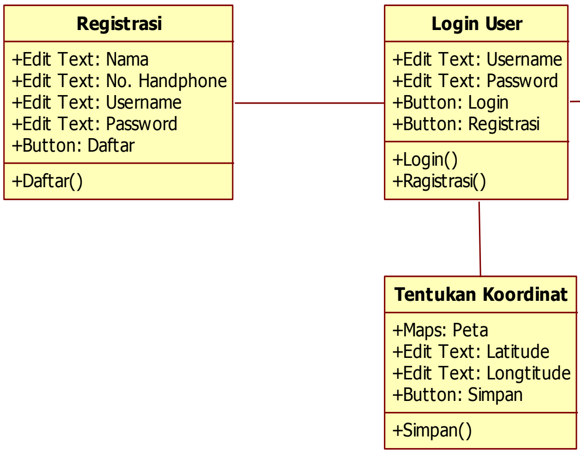

Figure 2. Class Diagram Login User

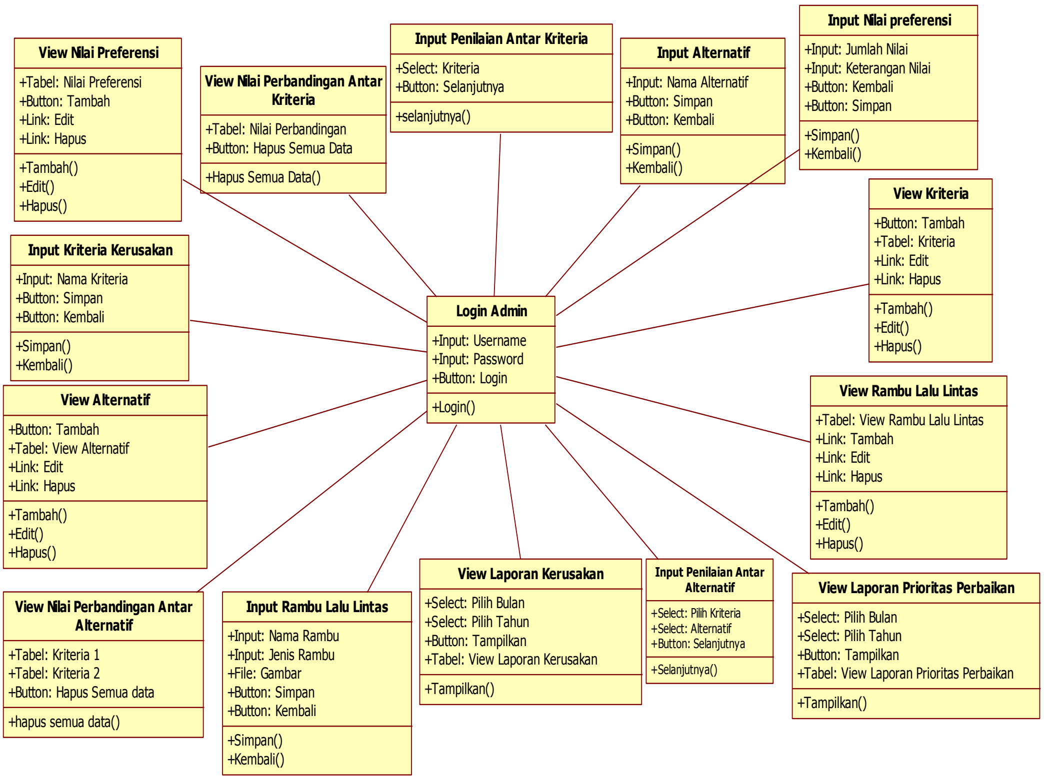

Figure 3. Class Diagram Login Admin

The login diagram class user consists of 4 classes, namely registration, user login, type of damage and determine coordinates. The admin login diagram class consists of 15 classes, namely, admin login, traffic sign damage criteria input, criteria view, alternative input, alternative view, preference value input, preference value view, traffic sign input, traffic sign view, assessment input between criteria, comparison value view between criteria, alternative assessment input, comparison value view between alternatives, comparison value view between alternatives, View traffic sign crash reports, view repair priority reports.

III. RESULTS AND DISCUSSION

This chapter produces application interface design on the web [22] and android [23] using the Java programming language, MySQL as database storage and system testing using Black Box[24].

a) Application interface on the web

The image below is the interface of the application on the web, namely login, comparison between criteria, comparison between alternatives, traffic sign damage reports and repair priority reports.

Figure 4. Interface Login

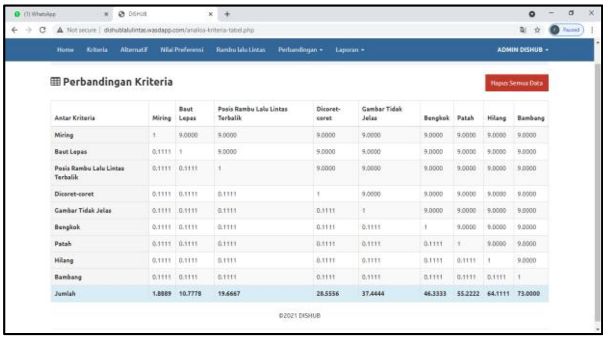

Figure 5. Comparison Between Criteria

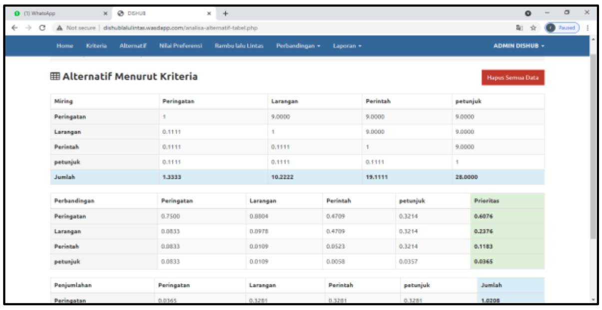

Figure 6. Comparison Between Alternatives

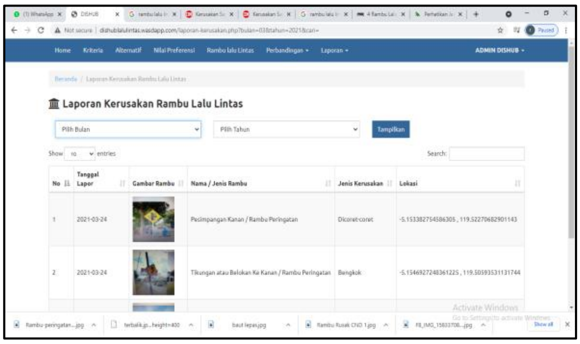

Figure 7. Traffic Sign Damage Report

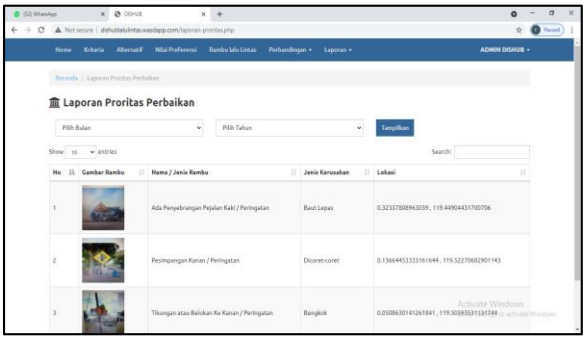

Figure 8. Improvement Priority Report

b) *Interface* aplikasi pada android

The picture below is the interface of the application on Android, namely login, input type of sign and coordinate points.

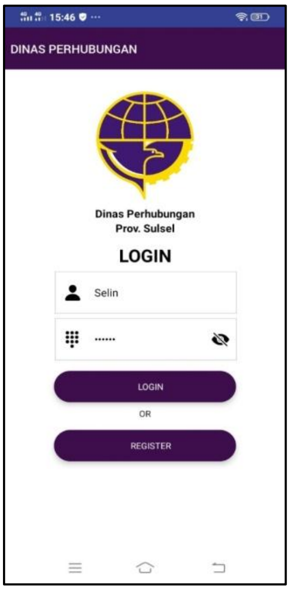

Figure 9. Interface Login User

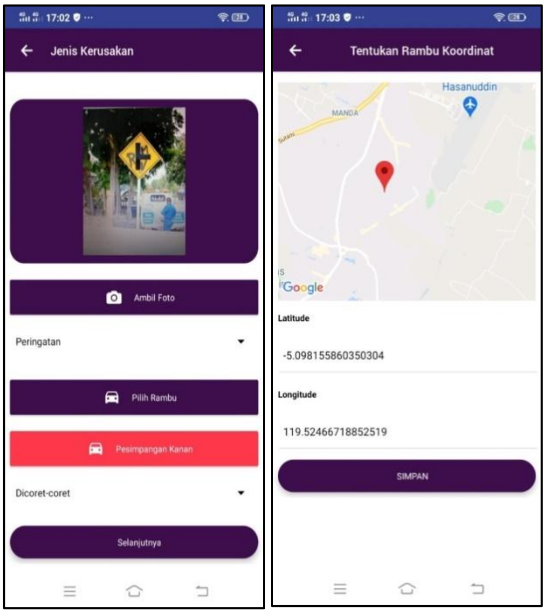

Figure 10. Input Type of Signs and Coordinate Points

c) Black Box Testing

System testing in this study using Black Box [25], by testing the resulting modules on web and android platform applications. In Table 8 it can be seen that the total modules tested are 40 starting from input to determining traffic sign coordinates. Of the 40 modules, all tests were declared successful.

IV. CONCLUSION

The conclusion that can be drawn from the presentation above is to implement the Analytical Hierarchy Process algorithm into the application for priority improvement of traffic signs using 2 (two) web-based platforms and android. System design using UML produces use cases (2 actors, admin and user) and class diagrams (15 admin classes and 4 user classes). The Black Box used as a test produced 40 modules of which all modules were in line with expectations.

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