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Implementation of SAW Method for Design and Development Apartment Recommendation System in Tangerang Using Mobile-Based

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***Abstract*— The house is no longer the sole type of residence available while looking for a place to live. Apartments are a solution for those who need a place to live in locations with limited land, such as Tangerang, in today's period. However, criteria are needed to choose an apartment based on a person's needs, thus in this project, we will develop and create an apartment recommendation system in Tangerang using the SAW approach to make it easy for people to choose the best apartment. The user's choice will be determined by the recommendation system based on their interests, activity, and other data. To put the recommendation system into action, the FMADM method must be employed. A Simple Additive Weighing (SAW) approach is required to complete this FMADM, which is a mechanism for computing the number of performance appraisals for each alternative based on all criteria. This recommendation system is called APARTKU, and it was created with HTML5, CSS, and AngularJS, as well as the Ionic Framework and the Firebase Database. The system was then put to the test by administering questionnaires to 32 respondents using the DeLone and McLean methodologies, and the results were tallied using the Likert Scale method, yielding a score of 90.64 percent, based on the interval on the Likert Scale technique, these results imply that the application has been constructed and designed very well.**

***Index Terms*— Apartment; Likert Scale; Recommendation System; Simple Additive Weighting; Tangerang**

I. INTRODUCTION

Apartments provide a solution for everyone who needs a place to live in locations with limited land, such as Tangerang, and in the era of the 2020-2021 pandemic, many people will require apartments as a self-isolation location if they are exposed to the COVID-19 virus. At home, self-isolation should be possible. It's just that some people are concerned that, despite the fact that the costs of self-isolation at home are entirely borne by the patient, there will be leakage [1]. The results of the survey on the level of public interest in apartments in the Tangerang area showed that 82.2 percent of respondents (51.5% male and 48.9% female) with an age range of 16-58 years are still hesitant to choose an apartment in Tangerang, with 82.2 percent answering "Yes" and 17.8 percent responding "No".

These problems are the focus of this study, which aims to discover solutions by developing and designing an apartment recommendation system for inhabitants in and around the area who are looking for a place to live or a place of solitude to find apartments that meet the community's requirements. This recommendation system has gained in popularity and is now used in a wide range of applications, including movies, novels, research articles, and social tags, to mention a few [2].

To make the procedure easier and faster, a computation approach must be used to implement this recommendation system. The method is Fuzzy Multiple Attribute Decision Making (FMADM), which is a technique for determining alternative options based on a set of criteria [3]. There are several methods that can be used to solve this FMADM problem, including Simple Additive Weighting (SAW), Weighted Product (WP), ELECTRE, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and Analytic Hierarchy Process.

In this study, the Simple Additive Weighting (SAW) method is used for the apartment recommendation system in the Tangerang area. The SAW method, also known as the Simple Additive Weighting method, is the most well-known and commonly used method for dealing with FMADM difficulties. The SAW method's fundamental idea is to determine the overall weight of each alternative's performance rating based on all criteria [4].

The basis used in making this application is mobile-based where making this application uses the Ionic framework. Ionic is a framework for designing and developing mobile and web applications. Typically, mobile applications require specific tools to develop

and are quite time consuming and costly, however Ionic development does not. Ionic, on the other hand, is a cross-platform application that uses HTML5, CSS, and Javascript [5]. Why use a mobile platform? Because the app will later require a Global Positioning System (GPS) in order to obtain distance data between the user and his apartment using the Spherical Law of Cosines, which is a method for accurately calculating the distance between the user's point and the selected location. After the application is development, the user satisfaction level is calculated using questions including the DeLone and McLean model variables and the Likert Scale approach once the program has been constructed.

I. THEORETICAL BASIS

A. *Apartment*

The apartment is one of the places where the general public really needs to live. According to KBBI (*Kamus Besar Bahasa Indonesia*), an apartment (apar.te.men) is a one-story dwelling with a sitting room, bedroom, bathroom, kitchen, and other amenities placed in a huge and elegant multi-story building [6].

B. *Recommendation System*

The recommendation system is a solution to solve problems for consumers such as providing several suitable items even though there are lots of items [7]. Recommendation systems can also be classified into three categories based on how the recommendations are made, including Collaborative Filtering (CF), Content-based Recommendations, and Hybrid approaches. Collaborative Filtering is one of the most widely used and successful categories for recommending items because it is on other users in the system to suggest items or products to specific users. Then there is Content-based Recommendation (CR), which makes recommendations based on the similarity of items to preferences. Users propose "Comedy Movies" to users who enjoy comedy films, and the Hybrid technique, which combines the two previous categories, namely Collaborative Filtering (CF) and Content-based Recommendation (CR) [8].

C. *Fuzzy Multiple Attribute Decision Making*

Fuzzy Multiple Attribute Decision Making (FMADM) is a decision-making technique which selects the best alternative from a series of feasible alternatives based on several attributes [9]. Problems related to FMADM include several components such as decision making, a set of unknown variables, and a set of results obtained from each alternative pair [10].

D. *Simple Additive Weighting*

Simple Additive Weighting is an extension of the SAW method and is often also referred to as The Weighted Summing Method. The main principle of the SAW method is to calculate the total weight of the performance appraisal for each alternative across all criteria where the highest overall score is the best alternative that will be selected later [11]. There are several steps to complete this SAW method including [12]:

1) Determining the Alternative that is A_i.
2) Determine the criteria that will be used as a reference in making decisions, namely C_j, After that, the type of criteria is defined, whether the benefit criteria or the cost criteria.
3) Provide a rating that corresponds to the alternative value on each criterion.
4) Determining preference weight or importance level (W_i) of each criterion.

$$W = [W_1, W_2, W_3, \dots, W_n] \quad (1)$$

5) Create a match rating table for each alternative on each criterion.
6) Make decision (X) which is formed from the table of suitability ratings of each alternative on each criterion.

$$X = \begin{bmatrix} X_{11} & \dots & X_{1j} \\ \dots & \dots & \dots \\ X_{i1} & \dots & X_{ij} \end{bmatrix} \quad (2)$$

7) Normalize the decision matrix by calculating the normalized performance rating value (r_{ij}) from alternative A_i on criteria C_j.

$$r_{ij} = \begin{cases} \frac{X_{ij}}{Max_i(X_{ij})} : benefit \\ \frac{Min_i(X_{ij})}{X_{ij}} : cost \end{cases} \quad (3)$$

8) Result of normalized performance rating value(r_{ij}) form a normalized matrix (R).

$$R = \begin{bmatrix} r_{11} & \dots & r_{1j} \\ \dots & \dots & \dots \\ r_{i1} & \dots & r_{ij} \end{bmatrix} \quad (4)$$

9) Calculating the final preference value (V_i).

$$V_i = \sum_{j=1}^{n} W_j r_{ij} \quad (5)$$

E. *Likert Scale*

Likert Scale is one of the popular instruments to measure subjective traits as measured through feelings, behavior, expressions, and personal opinions that can be obtained using a questionnaire that can determine a person's approval or dissatisfaction with the level of success [13]. The Likert scale was developed by Likert in 1932 and consists of a series of questions that serve as an indicator of the quality of a question. Each question has a score from 1 to 5 for each question [13].

TABLE I. DESCRIPTION OF EACH SCORE ON A LIKERT SCALE

Score	Description
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

Then it is calculated by looking for the index value to get the result.

$$Indeks\% = \frac{Total\ Respondents\ x\ likert\ score}{Likert\ highest\ score}\ X\ 100 \quad (6)$$

II. RESEARCH METHODOLOGY

In the method section of this research, there are several stages to design and build an apartment recommendation system in Tangerang using the mobile-based Simple Additive Weighting (SAW) method so that it can run as planned which can be seen in Figure 1.

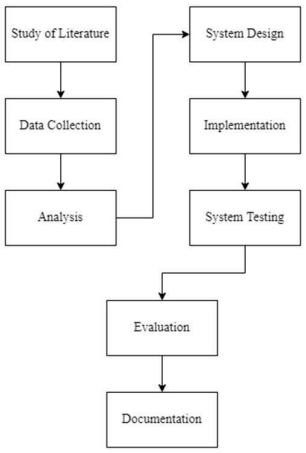

Figure 1. Research Diagram

III. RESULT AND DISCUSSION

A. Study of Literature

At this stage, namely collecting various reference materials regarding the problems that will be used as research and understanding of the Simple Additive Weighting method that will be used as a recommendation system in this study from various journals, articles and several other references that support this research.

B. Data Collection

At the data collection stage, apartment object data was collected from the company official Traveloka website https://www.traveloka.com and by looking for various document studies that provided various types of apartments in the Tangerang area.

C. Analysis

At this stage, an analysis of the method used and apartment data will be tested which will be tested in this study using the Simple Additive Weighting method or the Spherical law of Cosines method.

D. System Design

At the design stage starting from designing the work process of the recommendation system by using a diagram consisting of a Flowchart or Data Flow Diagram and also designing an interface (User Interface) using the Figma software so that the UI results are satisfactory and describes some of the features that must be needed on the system. application. First of all, to make an application, you need a Flowchart and an interface design as shown in Figure 2 and 3.

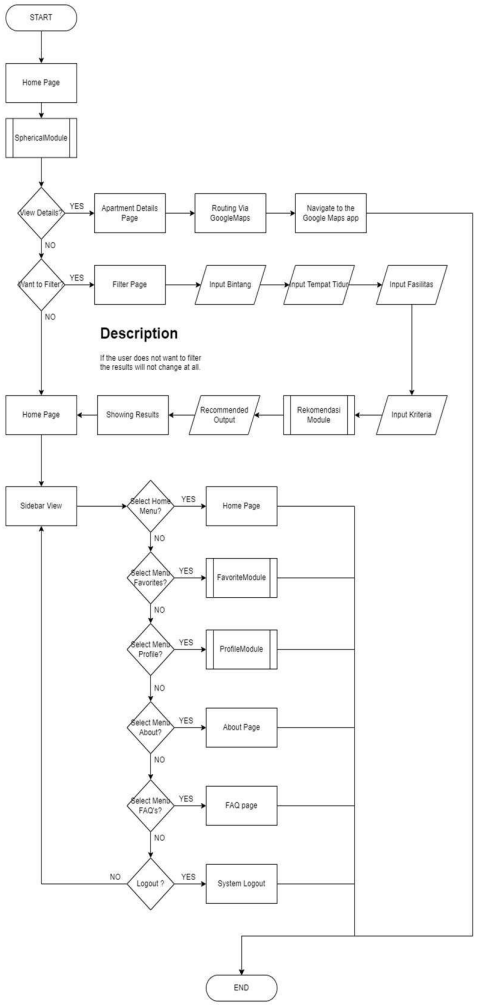

Figure 2. Flowchart of the Entire Application System

Figure 2 is the workflow of the entire system of the APARTKU application which will display the Home page after which there is a *Spherical Module* process to get data on the distance between the user and the

apartment when first opening the APARTKU application, on the Home page itself it will display several apartments and their information. Users can also see the details of the apartment by simply clicking on one of the apartments and users can also route each apartment where the user will be directly directed to the Google Maps application to make the route. Then filter according to the desired category such as star category, bed category, facilities category, and criteria category. After that, there is a *Recommend Module* process based on criteria input by the user and then get the recommendation results on the Home page and if you don't filter, there will be no changes on the Home page. In APARTKU, there are also several menus that can be seen when the user opens the Sidebar view, including the Home menu, Favorites, Profile menus, About menus, and FAQ menus. And on the Sidebar users can also log out.

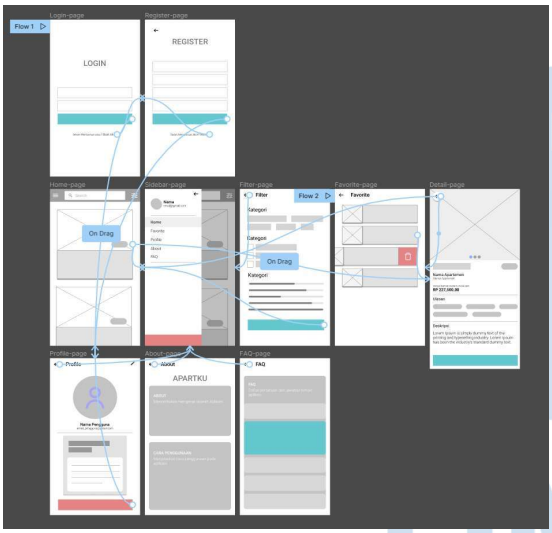

Figure 3. User Interface for the Entire System

Figure 3 is user interface or mockup made using the Figma software. The purpose of making this mockup is to make it easier to create a display during implementation by the developer that displays a design concept that seems real and to control so that the design display does not deviate from the original plan. In this system, the interface design or this mockup consists of the Home, Apartment Details, Sidebar, Filter, Favorite, Profile, Login, Register, About, and FAQ views that are visible.

E. Implementation

After designing the system, the implementation stage is carried out for the application creation process and makes the previously designed display. There are several pages in this application including the Home, Detail, Filter, Sidebar, Favorite, Profile, Login, Register, About, and FAQ pages. All of these pages have their respective roles as well as several features that can be used by users. Description that in the picture there are two pages on the mobile-based APARTKU application.

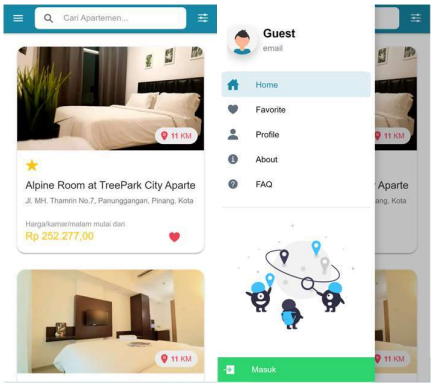

Figure 4. Home page and Sidebar

Figure 4 is the display for the APARTKU application when it is first opened, which will display all the apartments in the application with information such as name, address, distance, and apartment prices. When one of the apartments is clicked, it will display the Details page as shown in Figure 5. Then there is a sidebar to be used as access to other pages and can login by pressing the green button.

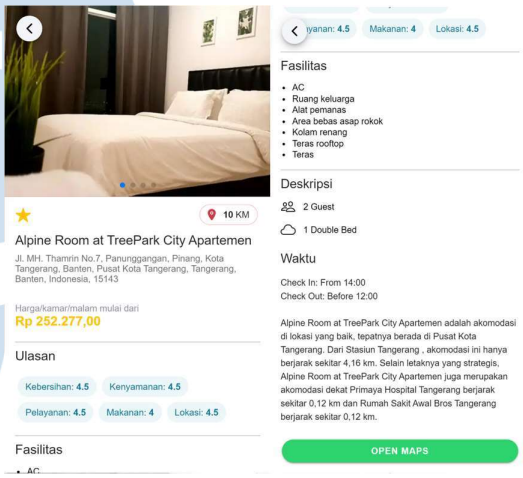

Figure 5. Apartment Details Page

Figure 5 will display detailed information about the apartment in full, such as more pictures, then information about the review criteria from other users, information about the facilities and descriptions of the apartment. Users can also route the apartment by pressing the green button and they will be directed to the Google Maps application.

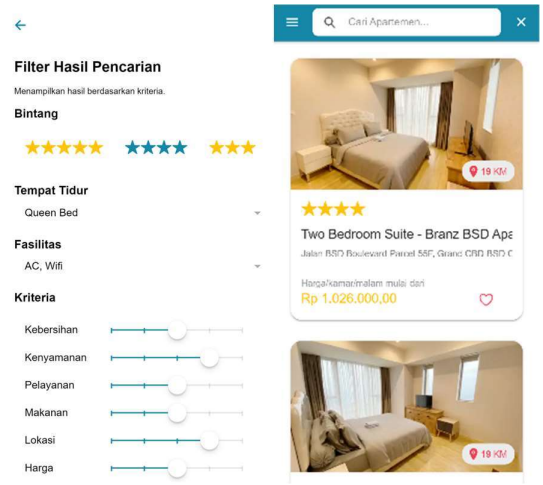

Figure 6. Filter page

Figure 6 is a feature for filtering where this application will recommend based on the results of input criteria from users and users can also filter apartments based on star categories, beds, and also facilities.

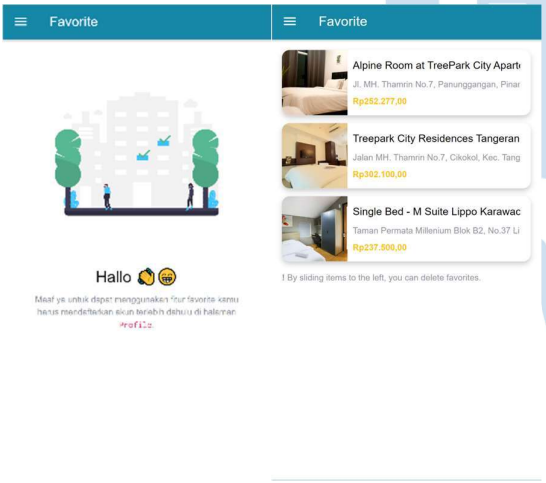

Figure 7. Favorite Pages

Figure 7 is a display of the favorites page where this feature will open when the user has logged in by going to the Profile page in Figure 8. This favorite page can be added by pressing the heart-shaped icon on the Home page as shown in Figure 4.

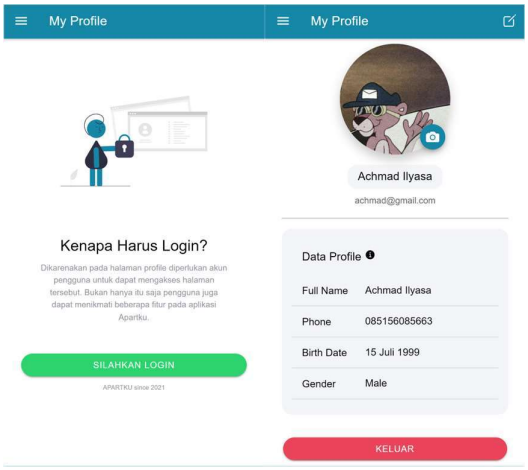

Figure 8. Profile page

Figure 8 is a profile display where this page will open when the user has logged in, to login the user only needs to press the green button and will be directed to the login and register page as shown in Figure 9. The profile page will display user information such as photos, name, phone number, date of birth, and gender, on this page you can also log out by pressing the red button.

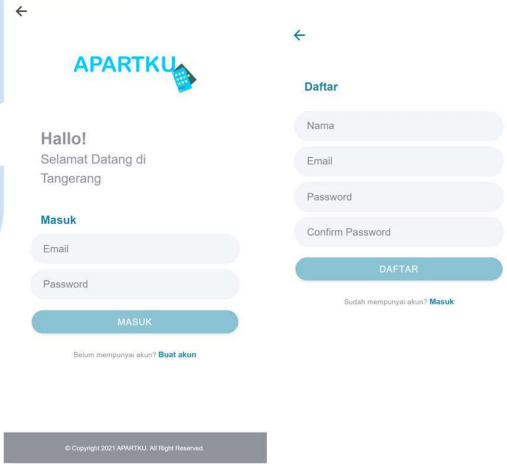

Figure 9. Login and Register page

Figure 9 is a display of the login and register pages for users if they want to register their accounts with the APARTKU application. The login function can open several features in the application, such as being able to save the best apartments and displaying the profile page in Figure 8.

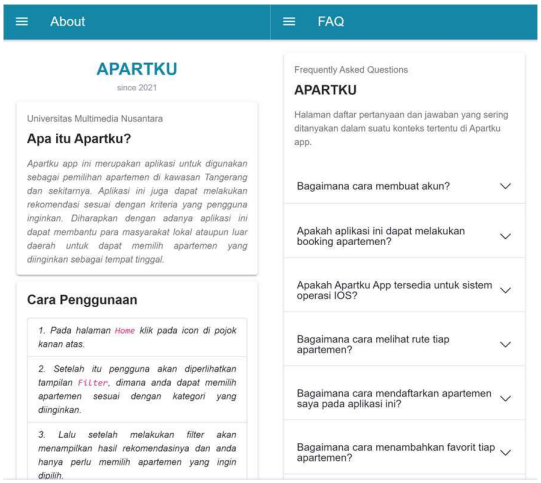

Figure 10. About page and FAQ

Figure 10 is the About and FAQ page where the about page will explain the APARTKU application and how to use it. Meanwhile, the FAQ (Frequently Asked Question) page is a page that lists questions and answers that are often asked in a certain context in the APARTKU application. Like how to see the route of each apartment or how to create an account and many more.

F. Systen Testing

At this stage, the application system testing process is carried out by testing each part of the system, to ensure it runs well or not and testing the application using a mobile base on the Android operating system in Figure 11.

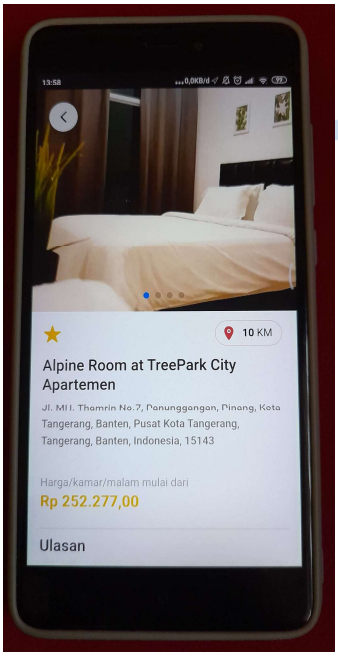

Figure 11. Testing Mobile Device Applications

G. Evaluation

After the application program is complete, system testing is carried out to determine the level of user satisfaction with the application by asking questions about the DeLone and McLean method variables as shown in Figure 12 to 32 people consisting of 26 people who are married and 6 students from out of town studying in Tangerang with aged over 18 years who need a place to live, after that it is calculated using the Likert Scale method to get the results of the level of user satisfaction.

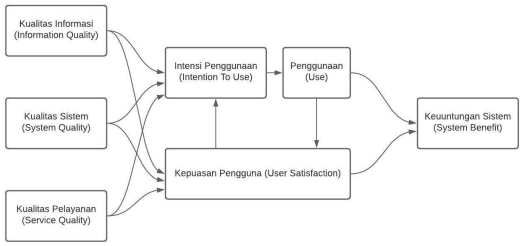

Figure 12. Variables of the DeLone and McLean

Figure 12 is a variable from the DeLone and McLean method which consists of System Quality, Information Quality, Service Quality, Usage Intentions, User Satisfaction, and System Benefit. After knowing the variable then it is applied to a question to get results which later each question will be calculated using the formula from the Likert Scale method.

$$Indeks\% = \frac{((SD*5)+(D*4)+(N*3)+(A*2)+(SA*1))}{(5*Total\ Respondents)}\ X\ 100 \quad (7)$$

TABLE II. LIST OF QUESTIONS

Code (Qi)	Question
Q1	Is APARTKU easy to use?
Q2	Does APARTKU have features that are easy to understand?
Q3	Does APARTKU have complete information about each apartment?
Q4	Can APARTKU find the route map for each apartment accurately?
Q5	Does APARTKU up and operating without any issues?
Q6	Does the search system in APARTKU have suitable or relevant results?
Q7	Does APARTKU meet your needs in finding the right apartment?
Q8	Does APARTKU have the best recommendation results for users for all apartments?
Q9	Does APARTKU UI/UX appealing enough for you to use it??
Q10	Does APARTKU have a complete list of apartments in the Tangerang area??

TABLE III. DATA FROM QUESTIONAIRE ANSWERS

Code (Qi)	SD	D	N	A	SA
Q1	0	0	2	10	20
Q2	0	0	2	10	20
Q3	0	0	4	7	21
Q4	0	1	5	7	19
Q5	0	0	2	15	15
Q6	0	0	3	10	19
Q7	0	0	4	8	20
Q8	0	0	3	10	19
Q9	0	0	2	9	21
Q10	0	0	4	9	20

Tables 2 and 3 are a list of questions and a list of respondents' answers to their questions. After the questionnaire answer data has been collected, it is continued to calculate each variable question using the Likert Scale formula to get the final result of user satisfaction with a score for each answer.

After getting the results of the indexs for each variable, the success of the system is summed by calculating the average value of the index results of all the questions that have been obtained. With the results of 90.64% the index can be defined that the results are very agreeable based on the Likert scale distance interval which can be seen in Table 4.

TABLE IV. LIKERT SCALE DISTANCE INTERVALS

Index %	Description
0% - 19.99%	Strongly Disagree
20% - 39.99%	Disagree
40% - 59.99%	Neutral
60% - 79.99%	Agree
80% - 100%	Strongly Agree

H. Documentation

In the last stage, a complete report is prepared with the analysis that has been obtained at the beginning of the stage until the final results can be documented as scientific research.

IV. CONCLUSION

The conclusion from designing an apartment recommendation application in the Tangerang area with the mobile-based Simple Additive Weighting method using the Ionic framework called APARTKU was successfully development and designed to find apartments in Tangerang according to user criteria. This application has also been tested for user satisfaction levels by 32 people consisting of 26 married people and 6 out-of-town students studying in Tangerang with ages over 18 years which has a final result of 90.64% which indicates that this application is very good to use. as a recommendation system application based on a Likert scale distance interval. Thus, the application for apartment recommendations in the Tangerang area using the mobile-based Simple Additive Weighting method called APARTKU has been successfully designed and development.

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