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DSS for Mobile-Based Determination of the Quality of Gayo 1 Coffee Seedlings by Combining the AHP-WP Method

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ABSTRACT

Determining the quality of Gayo 1 coffee seeds with manual calculations can affect time efficiency because manual calculations often result in inconsistent and time-consuming calculations. A decision support system is needed to determine the quality of Gayo 1 coffee seeds with consistent and accurate calculations and processed through computational speed. Applying the AHP-WP method can determine the quality of coffee seeds of the Gayo 1 variety at IP2TP Gayo. The discussion that becomes the focus is the application of the AHP method to determine the weight of the coffee seed criteria. The resulting weight can be continued in the calculation of the WP method to determine the quality of the Gayo 1 coffee seed based on the alternative preference value or vector S. The results of the study provide information regarding the quality of coffee seeds that have been tested for quality.

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1. Introduction

The development of contemporary times that began from the 20th century until now became a forum for the development of science, especially science in communication and information technology. Information technology is utilized in various areas of life; one of the uses of information technology in agriculture. System engineering in agriculture can be used to solve a problem to achieve a goal.

The concept of a Decision Support System (DSS) or Decision Support System (DSS) was first expressed in the early 1970s by Michael S. Scott Morton with the term Management Decision Systems [1][2][3]. Making decisions is one of the most basic human activities [4]. According to Pahwi Decision Support System is an interactive information system that provides information, modeling, and manipulates data [5][6]. This system assists decision-making in semi-structured situations, where no one knows how decisions should be made [7]. A Decision Support System is represented as a system that can provide the ability to solve problems and communication skills for semi-structured problems [8]. The selection process in determining coffee seeds manually often results in inconsistent and time-consuming calculations. System engineering can play a role in replacing the process of determining the quality of coffee seeds by implementing a decision support system using methods to obtain consistent and accurate results in determining the quality of coffee seeds and processing through computational speed. The decision support system method applied is a combination of AHP-WP methods.

The AHP method has been applied in research to determine coffee beans' quality in Cafe Kaki Bukit Lembang with criteria of defect, water quality, color, smell, and size of beans [9]. The stage of finding alternative actions in determining the quality of coffee beans using the AHP method in this study is very complicated. After the normalization stage of the criteria's weight is completed, it must calculate the Eigenvalue of each criterion paired with each existing alternative. The combination of AHP-WP methods has been applied to determine superior chili seeds. This method can determine the choice of superior chili seeds. Still, it is not explained the type of chili that is an alternative, and researchers have not implemented the combination of these methods into the application of decision support systems [10].

This makes a fundamental difference from previous research. In this research, the AHP-WP method will be applied to the application of decision support systems. Determining the quality of coffee seeds can be done by accessing the application through a mobile-based device. The AHP method is used because this method has advantages at the stage of calculating the weighting of criteria. The WP method has advantages in the ranking process by having a preference value to determine rankings to make decisions. The decision support system was made mobile-based to make it easier for employees to test the quality of coffee seeds in multiple places. The AHP method is used to determine the preference weight of each criterion that determines the quality of coffee seeds. The resulting preference weight of the AHP calculation is used to calculate the value of alternative preference or vector S with a simpler calculation on the WP calculation to determine the quality of the coffee seed. This method will calculate the input of each coffee bean criteria and obtain information about the quality of coffee beans that have been tested for quality.

Balai Pengkajian Teknologi Pertanian Aceh (BPTP Aceh) Have a technical implementation unit that is Instalasi Penelitian dan Pengkajian Teknologi Pertanian Gayo (IP2TP Gayo). IP2TP Gayo Has a coffee genetic resource garden that does coffee breeding with one of the generative techniques by selecting coffee seeds and

manually determining the quality of coffee seeds. The rest of this paper is organized as follows: Section 2 discusses the materials and methods used in the experiment. Section 3 discusses system design. Section 4 is implementation, and section 5 is conclusions from this paper.

2. Materials and Methods

The framework describes the research process in a structured and systematic manner that will be applied to this research.

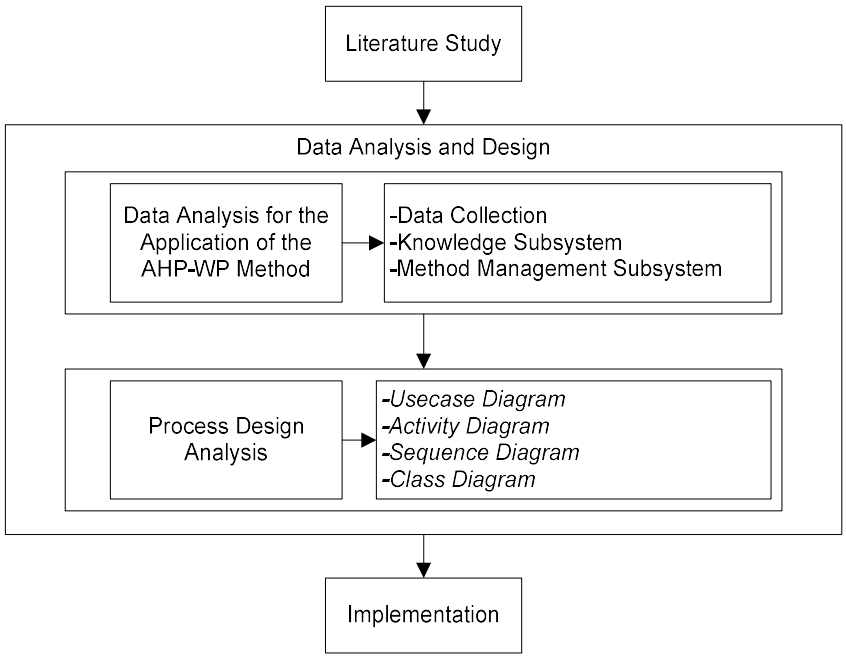


Figure 1 Schematic Representation of Research Stages

Figure 1 is a research phase to identify the quality of coffee seeds starting from the beginning to the result. The first stage is a literature study. This stage is carried out to obtain information sources that form the basis of the research theory of coffee seeds, such as the theory of DSS, AHP-WP Method, and Mobile App. This stage of analysis is collecting coffee seed data that will be tested for quality, then will be developed by the method of decision support system to identify the weight of coffee seed criteria to produce quality decisions on coffee seeds. The design stages will explain the function and process of the display section. Implementation is the stage of translating design into a programming language that can be recognized by the computer so that applications can be used. Hardware and Software are needed to support this research's implementation phase process.

2.1. Decision Support System

Michael S. Scott first introduced the concept of decision support systems in the 1970s as the Management Decision System. A decision support system is a system that can solve a problem by selecting alternative actions or solutions through data processing by applying decision support system methods [7]. Decision-making begins with identifying the problem, selecting relevant data, approaching certain methods, and evaluating the selection of alternative decisions [11].

2.2. Coffee Seeds

Coffee seeds are coffee beans that are used to multiply the coffee plant. Coffee seeds consist of fruit meat (mesocarp) that is protected with horn skin (endocarp) [12]. Coffee seed data is obtained during the interview stage with IP2TP Gayo. The data obtained are criteria that determine the quality of coffee seeds, including coffee seed moisture content, coffee seed life, the weight of coffee seeds, length of coffee seeds, and width of coffee seeds.

2.3. Gayo 1 Variety

Gayo 1 variety is one type of arabica coffee that is derived from the Gayo highlands of Aceh Province. On December 29, 2010, this variety was officially endorsed by the Minister of Agriculture of the Republic of Indonesia through Decree Number: 3998/KPTS/SR.120/12/2010 [13].

2.4. AHP and WP

AHP (Analytical Hierarchy Process) is a functional hierarchy with its main input being human perception with a scaled assessment determined by Thomas L. Saaty [14]. WP (Weight Product) is a method for determining decisions during the normalization stage, namely multiplication, to connect the attribute rating raised first with the weight of the attribute [15].

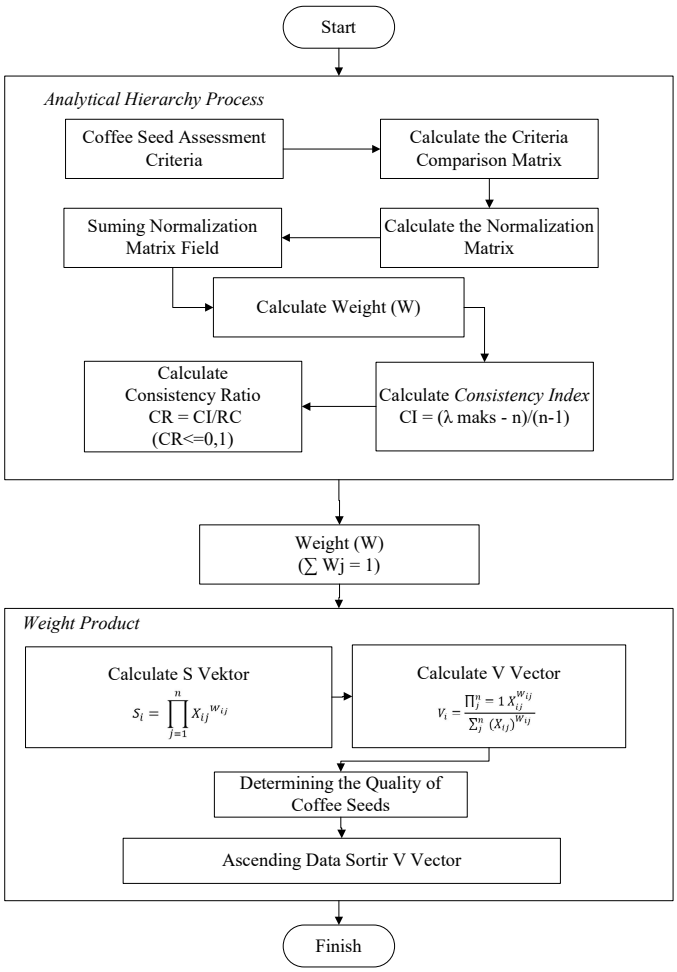


Figure 2 Schematic Representation of The Algorithm AHP-WP Method for Making Decisions [15]

The AHP decision-making method uses a functional hierarchy with an assessment based on a predetermined scale to determine a comparison matrix to get the weight (W) value. The weight (W) value is used in the WP method to obtain coffee seeds' quality (Figure 2).

2.4.1. Data Collection

Table 1 The Data Collection of Coffee Seed Sample Observation in IP2TP Gayo

No	Name	Moisture (C1) (%)	Age (C2) (days)	Weight (C3) (gr)	Length (C4) (cm)	Wide (C5) (cm)
1	Sample 1	39	30	0.024	1.3	0.7
2	Sample 2	39	10	0.026	1.5	0.8
3	Sample 3	41	07	0.026	1.5	0.9
4	Sample 4	39	15	0.026	1.4	0.7
5	Sample 5	40	04	0.026	1.5	0.9

Using a decision support system with the AHP-WP method combination, five seed samples will be tested for quality. The data obtained is a sample of gayo one variety coffee seeds (Table 1).

2.4.2. Knowledge Subsystem

Several values must be considered to determine the quality of coffee seeds (Table 2). Based on personal communication with Ishar obtained data for the parameters of the knowledge subsystem.

Table 2 Parameters of Knowledge Subsystem from Interview Results in IP2TP Gayo

	Parameters	Value	Description
C1	40%	5	Very Good
	39%	4	Standard
	> 40% & < 39%	1	Bad
C2	01 – 07 day	5	Excellent
	08 – 14 day	4	Very Good
	15 – 21 day	3	Good
	22 – 30 day	2	Standard
	> 30 day	1	Bad
C3	≥ 0,026 gr	4	Very Good
	≥ 0,025 gr	3	Good
	≥ 0,024 gr	2	Standard
	< 0,024 gr	1	Bad
C4	≥ 1,5 cm	4	Very Good
	≥ 1,4 cm	3	Good
	≥ 1,3 cm	2	Standard
	< 1,3 cm	1	Bad
C5	> 1,0 cm	4	Very Good
	≥ 0,9 cm	3	Good
	≥ 0,7 cm	2	Standard
	< 0,7 cm	1	Bad

2.4.3. AHP Method

In the AHP method, the first step is to enter the values for the criteria in the pairwise comparison matrix obtained from assessing the comparative nature of pairs.

Table 3 Pairwise Matrix At The Initial Stage in The AHP Method using The Saaty Scale

	C1	C2	C3	C4	C5
C1	1	3	5	7	7
C2	0.333	1	3	5	5
C3	0.2	0.333	1	3	3
C4	0.143	0.2	0.333	1	2
C5	0.143	0.2	0.333	0.5	1
Sum	1.819	4.733	9.666	16.5	18

Determining the paired comparison matrix. Criteria and alternatives are carried out by comparison in pairs. Comparison scoring in pairs on a scale of 1 to 9 (Table 3).

Table 4 Calculating The Normalization Matrix from The Paired Matrix

	C1	C2	C3	C4	C5	Sum
C1	0.55	0.634	0.517	0.424	0.389	2.514
C2	0.183	0.211	0.31	0.303	0.278	1.285
C3	0.11	0.07	0.103	0.182	0.167	0.632
C4	0.079	0.042	0.034	0.061	0.111	0.327
C5	0.079	0.042	0.034	0.03	0.056	0.241

Based on the normalization matrix (Table 4) determining the weight of coffee seed criteria,

$$W_1 = \frac{2.514}{5} = 0.503$$

$$W_2 = \frac{1.285}{5} = 0.257$$

$$W_3 = \frac{0.632}{5} = 0.126$$

$$W_4 = \frac{0.327}{5} = 0.065$$

$$W_5 = \frac{0.241}{5} = 0.048$$

Lambda maximum Value:

$$\lambda \text{ maks} = 5.266$$

Consistency Index (CI) Value:

$$CI = \frac{5.266 - 5}{5 - 1} = 0.071$$

Consistency Ratio (CR) Value:

$$CR = \frac{0.071}{1.12} = 0.063$$

Calculation of CR value that has been done qualifies on AHP calculation so that the calculation is considered consistent and acceptable. Preference weight values

generate $\sum W_j = 1$ so that the preference weight value can be used to calculate the WP method.

2.4.4. WP Methods

Table 6 Indicate Alternative Values From Parameters of The Knowledge Subsystem

	C1	C2	C3	C4	C5
Sample 1	4	2	2	2	2
Sample 2	4	4	4	4	2
Sample 3	1	5	4	4	3
Sample 4	4	3	4	3	2
Sample 5	5	5	4	4	3

Define alternative preferences; the criteria values in the tested samples were obtained from coffee seed sample data according to the provisions in the knowledge base subsystem (Table 6).

Calculating S Vector Value:

$$S_1 = (4^{0.503})(2^{0.257})(2^{0.126})(2^{0.065})(2^{0.048}) = 2.832$$
$$S_2 = (4^{0.503})(4^{0.257})(4^{0.126})(4^{0.065})(2^{0.048}) = 3.864$$
$$S_3 = (1^{0.503})(5^{0.257})(4^{0.126})(4^{0.065})(3^{0.048}) = 2.077$$
$$S_4 = (4^{0.503})(3^{0.257})(4^{0.126})(3^{0.065})(2^{0.048}) = 3.522$$
$$S_5 = (5^{0.503})(5^{0.257})(4^{0.126})(4^{0.065})(3^{0.048}) = 4.668$$

Calculate V Vector Value:

$$V_1 = \frac{2.832}{16.963} = 0.167$$
$$V_2 = \frac{3.864}{16.963} = 0.228$$
$$V_3 = \frac{2.077}{16.963} = 0.122$$
$$V_4 = \frac{3.522}{16.963} = 0.208$$
$$V_5 = \frac{4.668}{16.963} = 0.275$$

Determination of the quality of coffee seeds based on vector value parameter V Sample 1.

Table 7. Signify Quality Determination of The Quality of Coffee Seeds Results

No	Name	V Vector	Quality
1	Sample 5	0.275	Qualified
2	Sample 2	0.228	Qualified
3	Sample 4	0.208	Qualified
4	Sample 1	0.167	Qualified
5	Sample 3	0.122	Not Qualified

After obtaining the Vector V value of the arabica coffee variety with five samples of coffee seeds, coffee seeds can be considered quality if the value of Vector V ≥ the value of alternative Vector V Sample 1 (Table 7).

3. System Design

3.1. Usecase Diagram

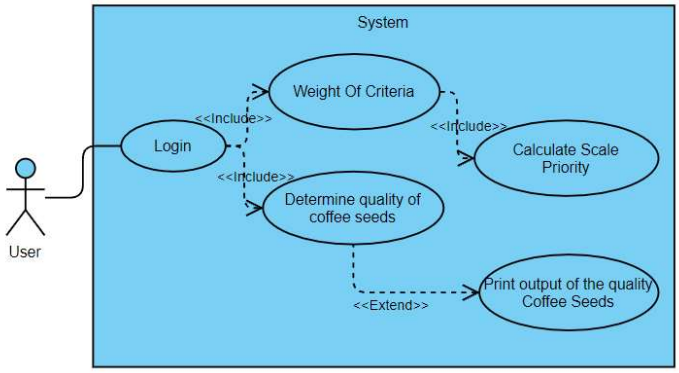
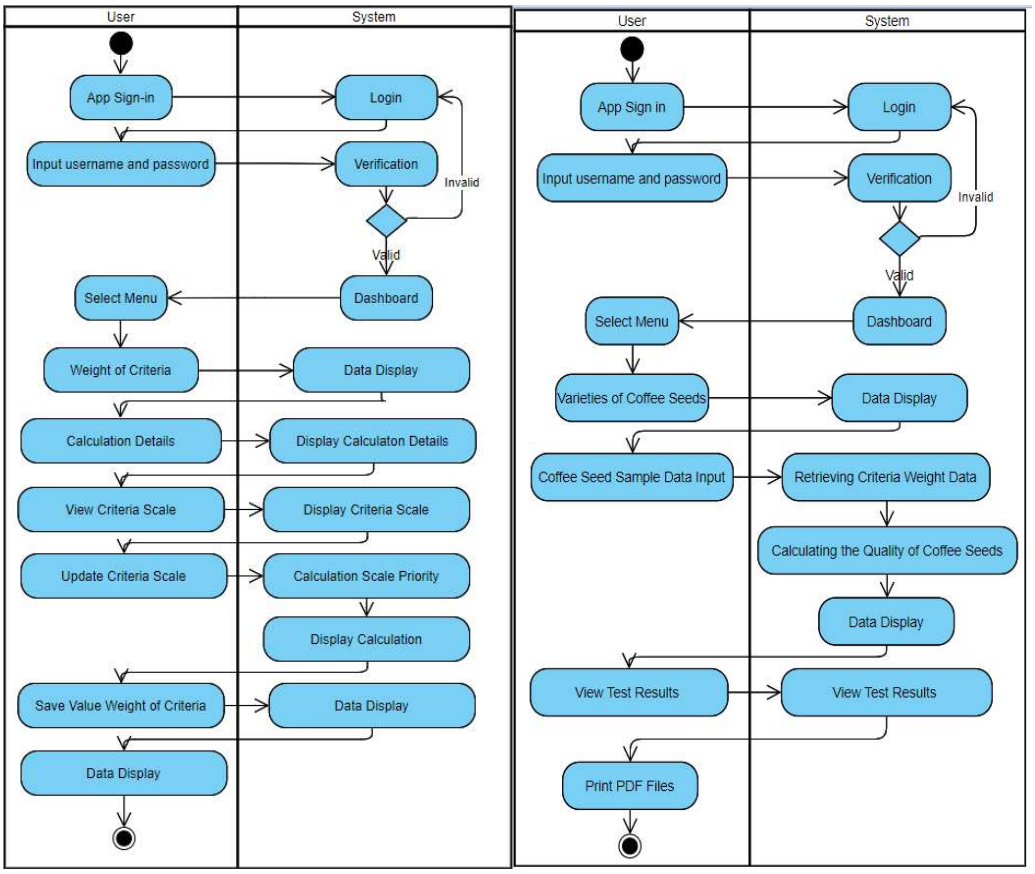


Figure 3 Actor Access Use Case

Actors will do the login process to manage the weight of coffee seed criteria by inputting the value of the priority assessment scale so that they can determine the quality of coffee seeds (Figure 3).

3.2. Activity Diagram

Below is an activity diagram of the user in processing data weight criteria and determining the quality of coffee seeds gayo one variety.



(a) (b)

Figure 4 (a) Activity Diagram of Coffee Seed Criteria Weights;
(b) Activity Diagram for Determining The Quality of Coffee Seeds.

Before analyzing the weight of the criteria, the first state is that the user must first log in to enter the system and select the criteria weight analysis menu to analyze the weight of the criteria and change the data (Figure 4a). Users can choose an alternative menu of coffee seeds that will be tested for quality with the first step of entering the system with a login state. After entering the system, users can enter coffee seed data, manage it, and print it into a PDF file (Figure 4b).

3.3. Sequence Diagram

Figure 5 sequence diagram shows the flow of the user doing data analysis of the weight of criteria. The user will do the login process and then choose the weight menu of the coffee seed criteria. The system will display data on the weight menu. Users can see the details of the criteria weight calculation and can change the assessment scale data.

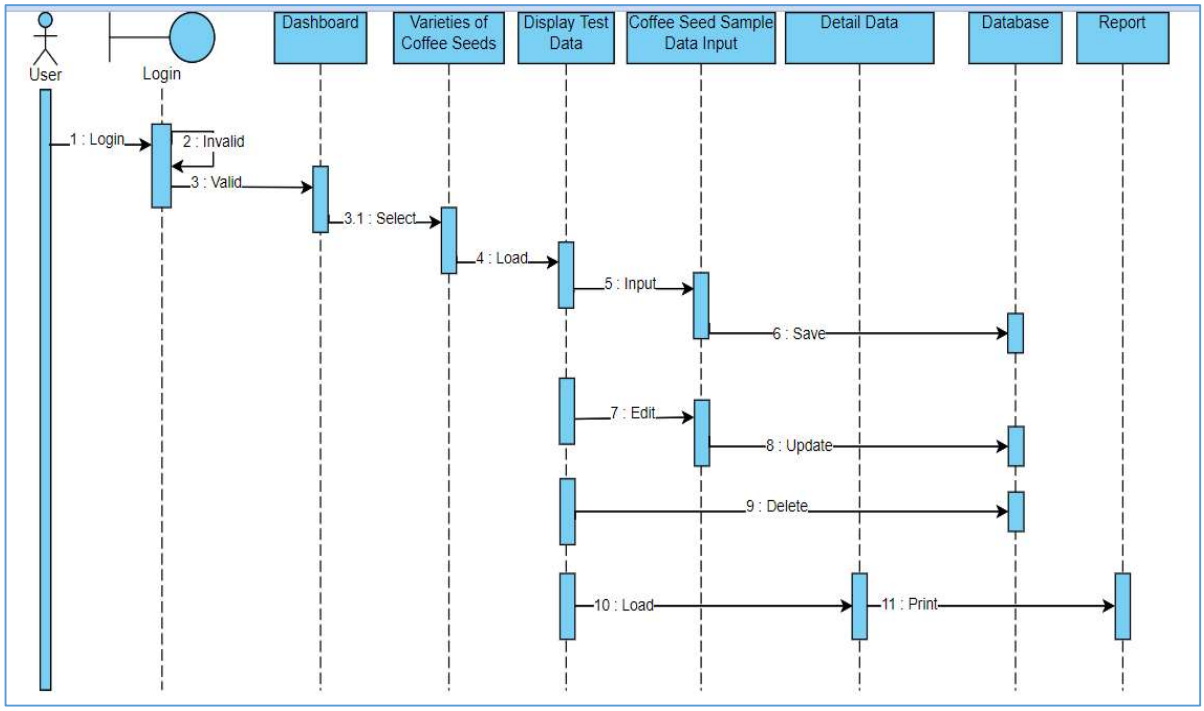


Figure 5 Sequence Diagram of Determining the Quality of Coffee Beans

The relationships between classes within the decision support system determine the quality of the coffee seeds. If the login is successfully done, other classes can be accessed (Figure 6).

3.4. Class Diagram

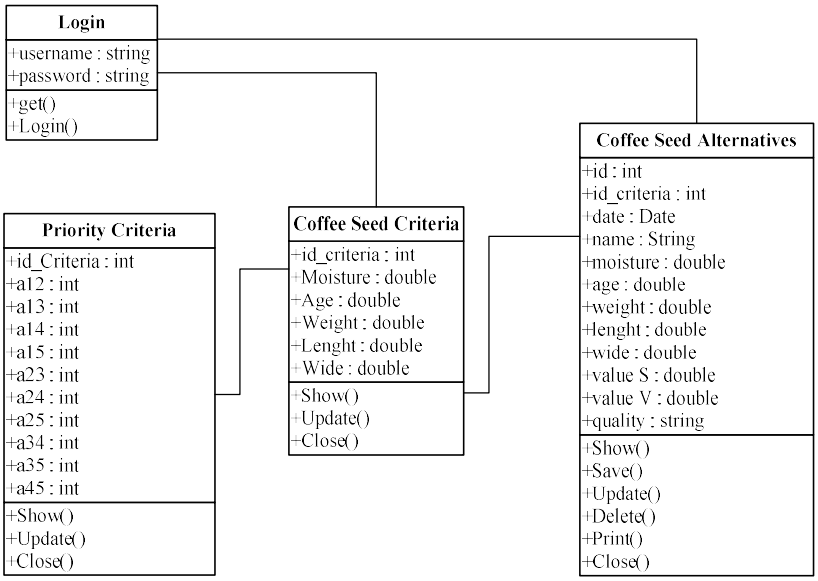
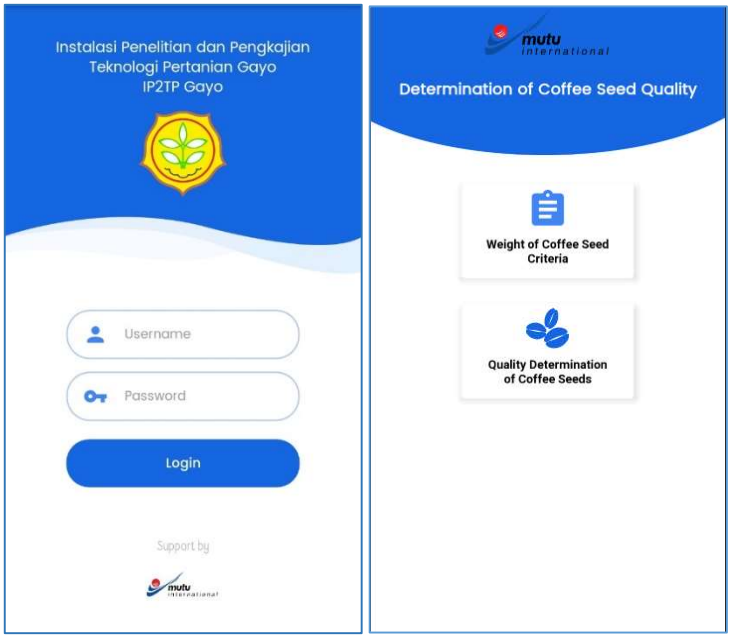


Figure 6 Class Diagram of Coffee Bean Quality Determination

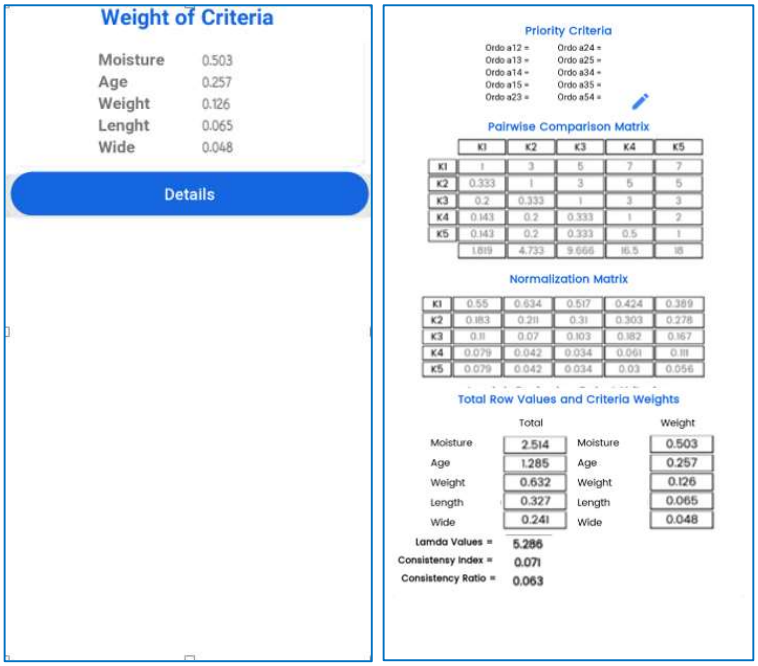
4. Implementation



(a) (b)

Figure 7 (a) Login Form (b) Dashboard Form

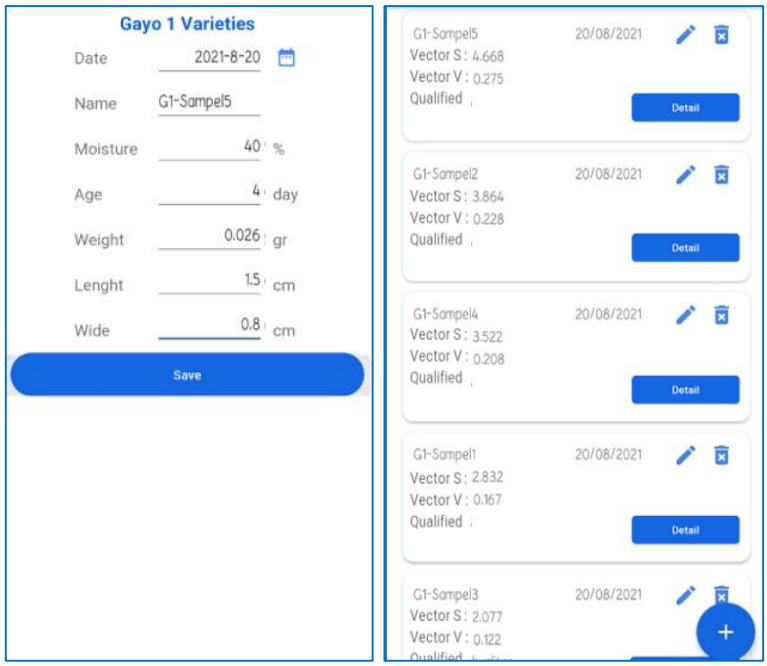
The Login page is an access page to be able to enter the system. To enter using the username and password recorded in the database (Figure 7a). The system will display the dashboard form if the login process is successful (Figure 7b).



(a) (b)

Figure 8 (a) Criteria Weight (b) Weight Detail Menu

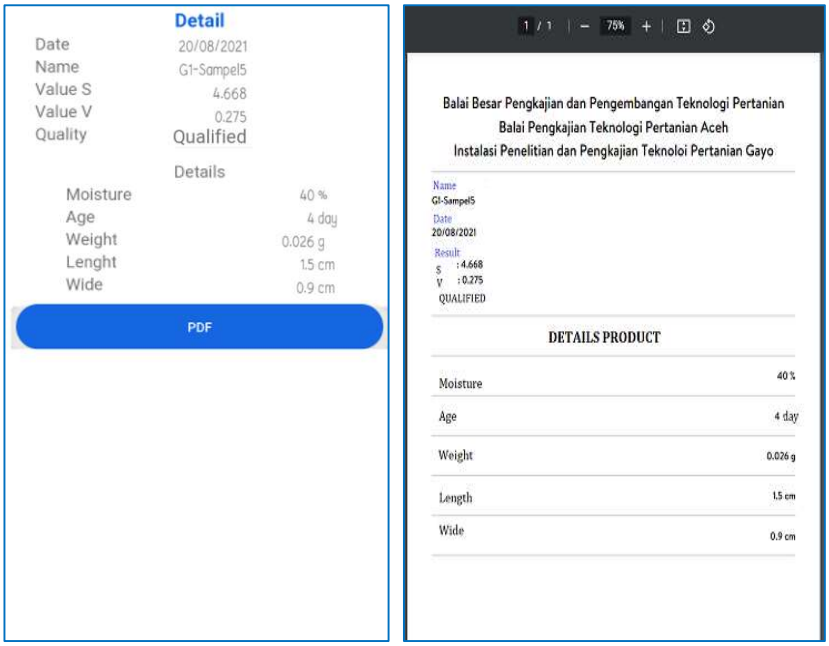
The weight menu displays the weight of each criterion (Figure 8a). The weight calculation detail menu displays the details of the criteria weight calculation using the AHP method (Figure 8b).



(a) (b)

Figure 9 (a) Coffee Seed Data Input Menu (b) Alternative Data

The coffee seed data input menu is used to add coffee seed data to be tested for quality (Figure 9a). The menu appears alternative data is a menu to display the data of coffee seeds that have been tested (Figure 9b).



(a) (b)

Figure 10 (a) Details of Coffee Bean Data. (b) Report of Determining The Quality of Coffee Beans

The contents of the details are the data of coffee seeds that have been tested for quality (Figure 10a). In this menu, there is a button to print coffee seed data into the PDF file used as a report (Figure 10b).

5. Conclusions

From the research results that have been done, some conclusions can be drawn. The calculation of weighting criteria in the AHP method obtained a consistency ratio of 0.063. In the AHP method, the calculation is declared correct and acceptable if the consistency ratio is less or equal to 0.1, considered consistent, and can be continued on WP calculations. Mobile-based applications that have been implemented by applying a combination of AHP-WP methods can manage the weight of coffee seed criteria and determine the quality of Gayo 1 Variety coffee seeds, whose results can be printed into PDF files. This mobile-based application can make it easier for employees to test and make decisions about the quality of coffee seeds in multiple places.

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