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Decision Support System for Selection of Superior Crystal Guava Seeds with SMART Method

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***Abstract*—** Crystal guava is one of the horticultural plants that play a role in meeting food needs, the horticultural sector is also able to contribute to domestic income. The purpose of this study was to produce a Decision Support System for the Selection of Crystal Guava. By using the PHP programming language and the database using MySQL and using the waterfall model for system development and *Unified Modeling Language* (UML) for system design. In this study, the data collection techniques used were literature study, observation and interviews. The result of this research is a decision support system is made to determine the proper selection of Crystal Guava Seeds. Users can input alternative data, view criteria data. Then the system will find a solution using the SMART method. After the decision is obtained, the system will display the final result of the calculation.

***Keywords*—** Decision Support System, Crystal Guava, SMART, Waterfall, UML.

I. INTRODUCTION

Indonesia is a tropical country that is rich in various types of horticultural crops. For the Indonesian people, horticultural crops can be a source of food and income, because they have high prices and have the opportunity to compete in the market (Karamina, 2016). Crystal guava is one of the horticultural plants that play a role in meeting food needs, the horticultural sector is also able to contribute to domestic income. The area of crystal guava cultivation in Indonesia is 14,203 ha with a production of 937.41 tons/year (Central Bureau of Statistics 2015). Crystal guava plants are agricultural commodities that can be easily cultivated and produce crop production throughout the year and the selling value is relatively high compared to other varieties of guava (Rustani, 2019). Superior crystal guava seeds are seeds that have a quality that is considered good by the business of farmer groups to be marketed to the public, the selection of the best seeds is usually determined by the farmers themselves or the community, the best seeds are usually seen from several criteria, namely acidity (Ph), soil texture, Age, stem and type of fertilizer (Anas dkk, 2020).

One of the obstacles in the process of selecting superior quality seeds is that poor seeds can cause slow growth, so that the crystal guava growth becomes slow and the crystal guava harvest is hampered (Fandinata dkk, 2018)

To provide an accurate selection of superior seeds, it is necessary to have a decision support system in the analysis process, so as to produce the right level of decision making. According to (Agustiara Duyan, 2019). Decision Support System is a system that is able to provide both problem solving skills and communication skills for semi-structured problems. Based on the evaluation of the system, it is expected to help farmers in determining superior crystal guava seeds that can support decision making. Methods within the *Multiple Criteria Decision Making* (MCDM) environment include: *Simple Additive Weighting* (SAW), *Technique for Order Preference by Similarity to Ideal Solution* (TOPSIS), *Weighted Product* (WP), *Simple Multi Attribute Rating Technique* (SMART), and others. In this study, the authors propose using a smart method that can accommodate the value of knowledge preferences that can produce decisions with a good level of accuracy. The *simple multi-attribute rating technique* (SMART) method is a multi-criteria decision-making method developed in 1997 by Edward. The SMART method is based on the theory that each alternative consists of a number of criteria that have a value and each criterion has a weight that describes how important the value of that weight is compared to other criteria. The SMART method is used more often because of its simplicity in responding to the needs of decision makers and analyzing responses (Magrisa , 2018).

II. LITERATURE REVIEW

A. Study of Literature

According to (Rachman dkk, 2017)from a study conducted with the title Decision Support System for Choosing Cayenne Pepper Using the *Simple Additive Weighting* (SAW) Method. The SAW method was chosen because it can determine the weight value for each

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attribute with a ranking process that will select the best alternative from a number of the best alternatives. Researchers provide a solution for a decision support system that can take into account all the criteria in the decision-making process in choosing the best cayenne pepper seeds.

Research conducted by (Syahputra dkk, 2017)with the application of a decision support system, with the title Decision Support System research in Determining the Quality of Fresh Food Intake Using the SMART (*Simple Multi Attribute Rating Technique*) Method. The SMART method is quite flexible because of its simplicity in the decision-making process to perform fairly accurate calculations. Researchers create a decision support system to determine the quality of food entry at the Medan Class II Agricultural Quarantine Center which is expected to later be able to assist in determining the quality of fresh food of plant origin. Fresh food of plant origin has several alternatives such as fruit, vegetables, cereals, nuts and plants plantation.

The research was conducted by (Fandinata dkk, 2018) from a study conducted with the title Decision Support System for Selection of Superior Seeds of Honey Guava Plants Using the *Simple Additive Weighting* (SAW) Method. This research is conducted to assist farmers in determining quality guava seeds and can simplify or speed up the work.

The research was conducted by (Baso, 2019) in a study entitled Analysis of Decision Support Systems for Selection of Cocoa Seeds Using the *Analytic Hierarchy Process* (AHP) Method in Noling Village, Bupon District, Luwu Regency Using the Expert Choice Application. The problem that occurs is comparing cocoa seeds such as dead stone (BB), MCC 02 (45), and Sulawesi 2 (BR-25), with the aim of knowing the best seed seeds among the three cocoa seeds. The AHP method is based on obtaining the best solution by decomposing complex problems into simpler forms.

The research was conducted by (Lintang , 2020) from the research conducted with the title Implementation of the Simple Multi Attribute Rating Technique Method in Determining the Land for Planting Sago Plants. This system aims to provide a solution to the problem of decision making in determining the right land for sago plants. This SMART method focuses on the weighting of each criterion that affects the final decision. The alternative of an area that tends to have a small value but giving weight to a large criterion greatly affects the final result.

B. Decision Support System

Decision support system is a system used to support managerial decision makers to expand their capabilities in semi-structured decision situations. Decision support systems are a tool for decision makers, but not to replace their judgmental role. The decision support system applies the process of updating information and analytical methods that can produce effective, profitable decisions for the company. Artificial intelligence-based decision support systems can perform diagnoses in the form of knowledge, expert analysis, pattern recognition, and others in the scope of various cases (Muslimin B, 2012).

C. Simple Multi Attribute Ranking Technique (SMART)

The Simple Multi Attribute Rating Technique method is a method for multi-criteria decision making developed in 1997 by Edward. The SMART method is based on the theory that each alternative consists of a number of criteria that have a value and each criterion has a weight that describes how important the value of that weight is compared to other criteria.

The SMART method is used more often because of its simplicity in responding to the needs of decision makers and analyzing responses. SMART uses a linear additive model to predict the value of each alternative and the decision-making method is flexible. This method provides a high understanding of the problem and can be accepted by decision makers (Magrisa et al., 2018).
According to Winata (2020) he steps in solving problems using the Simple Multi Attribute Ranking Technique (SMART) method are as follows:

1. Determining Criteria
   Determines the number of criteria used.
2. Determining Criteria Weight
   Determine the weight of the criteria for each criterion by using an interval of 1-100 for each criterion with the most important priority.
3. Criteria Weight Normalization
   Calculate the normalization of each criterion by comparing the value of the weight of the criteria with the total weight of the criteria. Using the formula:
4. Providing Parameter Values for Each Criterion
   Provide the value of the criteria parameter on each criterion for each alternative.
5. Determining Utility Value
   Determine the utility value by converting the criterion value on each criterion into a standard data criterion value. The utility value is obtained by using the equation (1)

$$u_j(a_i) = \frac{(C_{outi} - C_{min})}{(C_{max} - C_{min})} \times 100 \quad (1)$$

6. Determining Final Value
   Determine the final value of each criterion by transferring the value obtained from the normalization of the standard data criteria values with the normalized value of the criteria weights. Then add up the values of the multiplication (2)

$$u(a_i) = \sum_{j=1}^{m} w_j * u_j(a_i) \quad (2)$$

7. Ranking
   The results of the calculation of the final value are then sorted from the largest to the smallest value, the alternative with the largest final value indicates the best alternative.

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D. Crystal Guava

Crystal guava comes from Taiwan, entered Indonesia in 1998 brought by the Taiwan Technical Mission. Crystal guava has spread in various regions of Indonesia such as West Java, Central Java, East Java, DI. Yogyakarta, Lampung, West Kalimantan, South Sulawesi, Bengkulu and NTB. Crystal guava has a special advantage, namely the number of seeds is less than 3% of the fruit which is not found in other types of guava. The acid content of crystal guava is 0.44% and water content is 87.4%, the vitamin C content in crystal guava ranges from 127.1-133.9 mg/100g. Crystal guava has thick flesh and white color and has a sweetness level in the range of 11-12obrix. Crystal guava is usually used to the extent of eating the fruit, making pickles, or making fruit juice (Hutami, 2020).

E. Website

A website (often shortened to just a website, website or site) is a term for a group of web pages (web page), which are generally part of a domain name (domain name) or subdomain on the World Wide Web (WWW) on the Internet. A web page is a document written in HTML (Hyper Text Markup Language) format, which can almost always be accessed via HTTP, which is a protocol that conveys information from a website server to be displayed to users via a web browser, both static and dynamic which forms a single web page. a series of interconnected buildings, each connected by a network of courtyards.

The pages of a website are accessed from a URL that becomes the "root", which is called the homepage (the parent page; often translated as "home", "home page"), and is usually stored on the same server. Not all websites are accessible for free. Some websites require payment in order to become a subscriber, for example sites that display pornography, news sites, electronic mail services (e-mail), and others (Harminingtyas, 2014).

F. Hypertext Prepocessor (PHP)

PHP (Hypertext Preprocessor) is a server-side scripting language that integrates with HTML to create dynamic web pages that can create views based on current requests. PHP syntax and commands will be executed on the server then the results are sent to the browser in HTML format. Thus the program code written in PHP will not be visible to the user so that the security of the web page is guaranteed.

One of the advantages of PHP is its ability to connect to various kinds of database management system (DBMS) software. PHP has good connectivity with several DBMS, including Oracle, Sybase, mSQL, MySQL, Microsoft SQL Server, Solid, PostgreSQL, Adabas, FilePro, Velocis, dBase, Unix dbm, and not least all databases with ODBC interface (Barek dkk, 2019).

G. Mysql

In its development, MYSQL is also called SQL which stands for Structured Query Language. SQL is a structured language that is specifically used to process databases. SQL was first defined by the American National Standards Institute (ANSI) in 1986. MYSQL is an open source database management system.

MYSQL is a relational database management system. That is, the data that is managed in the database will be placed in several separate tables so that data manipulation will be much faster. MYSQL can be used to manage databases ranging from small to very large.

So, SQL is a query attached to a particular database or SMBD. In other words, SQL is a command or language inherent in SMBD. As a query language, SQL is supported by SMBD, such as MySQL Server, MySQL, PostgreSQL, Interbase, and Oracle. In addition, SQL is also supported by non-server databases, such as MS Access and Paradox (Novendri, 2019).

H. Visual Studio Code

Visual Studio Code (VS Code) is a lightweight and powerful text editor created by Microsoft for multiplatform operating systems, meaning that it is also available for Linux, Mac, and Windows versions. This text editor directly supports the JavaScript, Typescript, and Node.js programming languages, as well as other programming languages with the help of plugins that can be installed via the Visual Studio Code marketplace (such as C++, C#, Python, Go, Java).

There are lots of features provided by Visual Studio Code, including Intel license, Git Integration, Debugging, and extension features that add to the capabilities of the text editor. These features will continue to grow along with the addition of Visual Studio Code versions. This Visual Studio Code version update is also carried out periodically every month, and this is what distinguishes VS Code from other text editors.

The Visual Studio Code text editor is also open source, where you can view the source code and you can contribute to its development. The source code of this Visual Studio Code can also be seen on the Github link. This also makes Visual Studio Code a favorite of application developers, because application developers can participate in the process of developing Visual Studio Code in the future (Permana, 2019).

I. Unified Modeling Language (UML)

Unified Modeling Language (UML) is a standard specification language used to document, specify and build software. UML is a methodology in developing object-oriented systems and is also a tool to support system development (Hendini, 2016).

III. Research Methods

This study discusses data collection techniques and Calculation of the selection of crystal guava seeds using the SMART method.

A. Research procedure

The research procedure is the process used in obtaining data into information that is in accordance with the problem to be studied. The following is the research procedure used in the research on Decision Support System for Selection of Superior Crystal Guava Seeds

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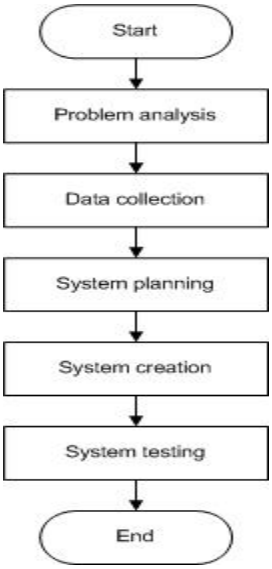
Using the SMART Method. The research procedure can be seen in Picture 1.



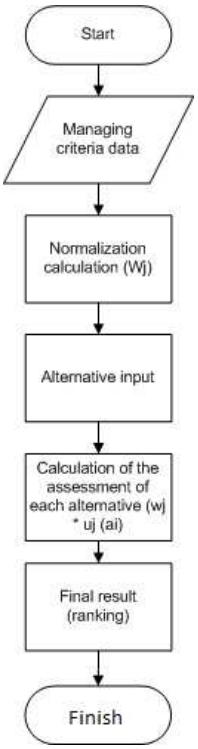
Picture 1. Research Procedure

B. Support System Design

System design is designing the system according to the existing problems and meeting the needs of system users, followed by thinking about how to form the system. The following is the system design used in this study.

1. Flowchart

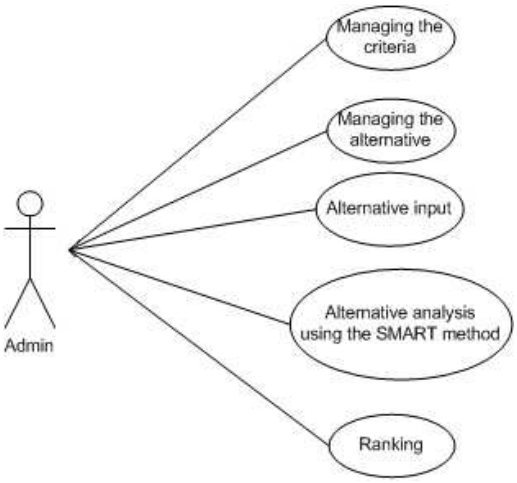
The following is a design process model illustrated with a flowchart. It can be seen in the picture 2.



Picture 2. System Flowchart

2. Use Case System Diagram

Use Case Diagram can be seen in the picture 3.



Picture 3. Use Case Diagrams

Use Case Diagram Explanation Table can be seen in the table 1.

Table 1. Explanation of Use Case Diagrams

Actor	Use Case Name	Description of Use Case
Users	Login	The user first logs in to the application.
Users	managing the criteria	Users can change the criteria data.
Users	managing the alternative	Users can see alternative.
Users	alternative input	User can add alternative input.
Users	Alternative Analysis Using the SMART Method	The system analyzes alternatives with data on each criterion so that it can generate values
Users	Ranking	Users can see the ranking results for the selection of crystal guava seeds.
Users	Logout	The user can exit the application.

E. SMART method

The steps taken in conducting SMART modeling in this study are as follows:

1. Determine the criteria and the weight of the criteria used.

In determining the superior crystal guava seeds there are several criteria used and the weights. The following criteria and weights are obtained. The criteria and weights can be seen in table 2.

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Table 2. Criteria for crystal guava seeds

Code	Criteria Name	Criteria Name	Weight Value
C1	Acidity	Benefits	100
C2	Soil texture	Benefits	60
C3	Age	Benefits	30
C4	Stem	Benefits	10
C5	Type of fertilizer	Benefits	40
	Amount		240

2. Calculate the normalized weight of each criterion

After assigning a weight value to each criterion, then the weight normalization is carried out, namely the weight of each criterion is divided by the total weight. The following are the results of normalizing the weights obtained so that the results are obtained as shown in table 3.

Table 3. Criteria Weight Normalization

Code	Criteria	Weight	Criteria Weight Normalization
C1	Acidity	100/240	0.416666667
C2	Soil texture	60/240	0.25
C3	Age	30/240	0.125
C4	Stem	10/240	0.041666667
C5	Type of fertilizer	40/240	0.166666667

3. Parameter Value Determination.

The values for each predetermined criterion can be seen in Table 4.

Table 4. Parameter Value

Criteria	Scale	Value
Acidity	5	1
	6	2
	7	3
Soil texture	Clay	1
	Burnt husk	2
	Loose	3
Criteria	Scale	Value
Age	4–6 month	1
	7-9 month	2
	10-12 month	3
	Moldy	1
	Bet	2
	Hardwood	3
Type of fertilizer	Flower Stimulant Fertilizer	2
	Compost	3

4. Alternative

In this process, several alternatives are used for assessment by filling in the values for the alternatives for each criterion by looking at the pre-determined parameter values. It can be seen in table 5.

Table 5. Alternative

Alternative	Criteria				
	Acidity	Soil texture	Age	Stem	Type of fertilizer
	C1	C2	C3	C4	C5
A1	7	Clay	9	Bet	Flower stimulant fertilizer
A2	5	Loose	6	Hardwood	Flower stimulant fertilizer
A3	7	Burnt husk	10	Moldy	Flower stimulant fertilizer
A4	7	Clay	4	Hardwood	compost
A5	5	Burnt husk	7	Moldy	Flower stimulant fertilizer
A6	6	Loose	12	Bet	compost
A7	6	Clay	4	Moldy	Flower stimulant fertilizer
A8	5	Burnt husk	6	Hardwood	Compost
A9	6	Clay	9	Hardwood	Flower stimulant fertilizer
A10	7	Clay	10	Moldy	Compost

The criteria values are then converted into a criterion value to determine the utility value. It can be seen in the table 6.

Table 6. Conversion of Alternative Values

Alternative	Criteria				
	Acidity	Soil texture	Age	Stem	Type of fertilizer
	C1	C2	C3	C4	C5
A1	3	1	2	2	2
A2	1	3	1	3	2
Alternative	Acidity	Soil texture	Age	Stem	Type of fertilizer
A3	3	2	3	1	2
A4	3	1	1	3	3
A5	1	2	2	1	2
A6	2	3	3	2	3
A7	2	1	1	1	2
A8	1	2	1	3	3
A9	2	1	2	3	2
A10	3	1	3	1	3

3. Calculating Utility Value

Calculating the utility value for each criterion. The utility value is needed when ranking each alternative so that it can be seen which alternative is feasible or not feasible to choose. Then it can be seen the utility value of each criterion from each alternative in the following table 7.

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Table 7. Utility Value

Alternative	Criteria				
	C1	C2	C3	C4	C5
A1	1	0	0.5	0.5	0
A2	0	1	0	1	0
A3	1	0.5	1	0	0
A4	1	0	0	1	1
A5	0	0.5	0.5	0	0
A6	0.5	1	1	0.5	1
A7	0.5	0	0	0	0
A8	0	0.5	0	1	1
A9	0.5	0	0.5	1	0
A10	1	0	1	0	1

4. Calculating Final Grades

Calculation of the final value/preference of each alternative References. Can be seen in table 8.

Table 8. Final Grades

Criteria					
C1	C2	C3	C4	C5	Final Grades
0.416666667	0	0.0625	0.020833333	0	0.5
0	0.25	0	0.041666667	0	0.291666667
0.416666667	0.125	0.125	0	0	0.666666667
C1	C2	C3	C4	C5	Final Grades
0.416666667	0	0	0.041667	0.167	0.625
0	0.125	0.0625	0	0	0.1875
0.208333333	0.25	0.125	0.020833333	0.166666667	0.770833333
0.208333333	0	0	0	0	0.208333333
0	0.125	0	0.041666667	0.166666667	0.333333333
0.208333333	0	0.0625	0.041666667	0	0.3125
0.416666667	0	0.125	0	0.166666667	0.708333333

5. Ranking

The results of calculations using the SMART method are obtained by ranking the results of the previous final value calculations, from the largest to the smallest value so that the highest value ranking can be obtained, namely seed 6. Can be seen in the table 9.

Table 9. Ranking Results

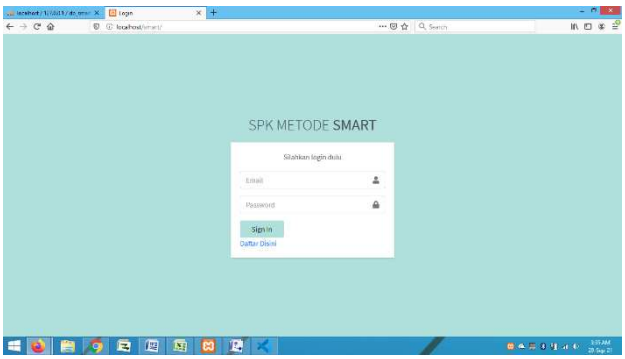
Alternative	Final Grades	Rank
A6	0.770833333	1
A10	0.708333333	2
A3	0.666666667	3
A4	0.625	4
A1	0.25	5
A8	0.3125	6
A9	0.291666667	7
A2	0.208333333	8
A7	0.1875	9
A5	0.708333333	10

IV. Results and Discussion

System implementation is the final stage of system design. The following are the menus in the decision support system program for crystal guava seedlings using the SMART method.

1. Login Page

On the admin login page, you must enter your email and password in order to enter the dashboard page. On the login page view can be seen in picture 4.



Picture 4. Login Page

2. Main Page

The main page is the initial view seen by the admin after the admin has successfully logged in, where on the main page there are Dashboard menus, Alternatives, Criteria, Smart calculation results and Ranking Results. The main page display can be seen in picture 5.

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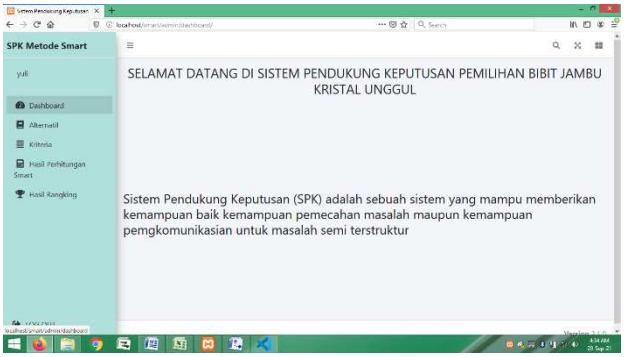
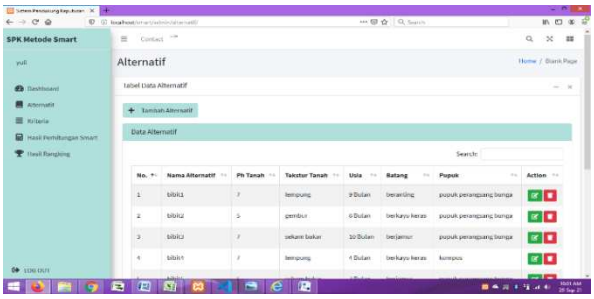


Picture 5. Main Page

3. Alternative Pages

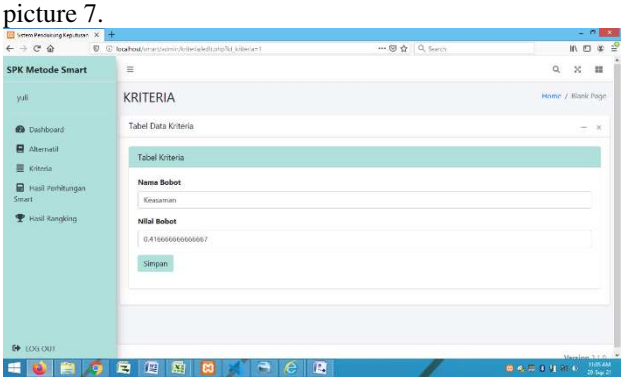
The alternative data page features add, edit, delete, search buttons. The alternative data page display can be seen in picture 6.



Picture 6. Alternative Page View

4. Criteria Data Page

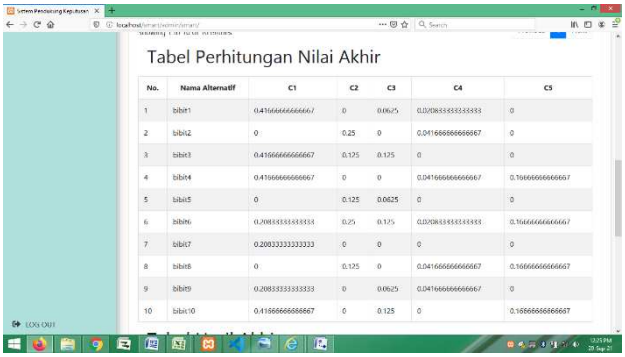
On this page displays data for each criterion and weight value. In the criteria data there is a field for editing. The criteria data page view can be seen in the picture 7.



Picture 7. Criteria Data Page View

5. Final Value Calculation Page

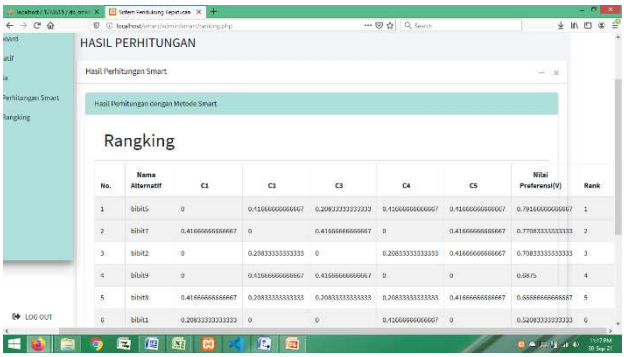
This page displays the SMART method calculation page. Can be seen in the picture 8.



Picture 8. Final Value Calculation Page Display

6. Ranking Pages

This page displays the ranking results. Can be seen in the picture 9



Picture 9. SMART Calculation Results Display.

V. CONCLUSION

The system is able to apply the SMART method of decision support in determining alternative choices of crystal guava seeds which are implemented into a web-based system. The SMART method model process can be used as a consideration or reference in the process of selecting guava crista seeds by providing the best alternative based on the ranking results that have been processed in the system. The application of the SMART method model has accurate results in providing the best alternative.

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