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Implementation of AHP and Black Box Testing to the Development of an Information System for Assessing the Feasibility of BUMDES Submissions

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ABSTRACT

The existence of institutional village enterprises (BUMDES) has never been adequately monitored in terms of the growth of village-owned businesses in each village. According to the data, there are 17 BUMDES in the Muara District that have been inactive for the most part. Due to the difficulty of monitoring the progress of BUMDES, a significant number of them have become stalled or even inactive. In addition, many BUMDES managers are frequently unprepared to operate the newly opened business. Readiness in terms of the quality of human resources also affects the formation of BUMDES. Consequently, the objective of this study is to facilitate the monitoring of business developments carried out by BUMDES actors in their respective villages, thereby facilitating the feasibility assessment of BUMDES. Aside from that, the purpose of this study is to determine the viability of applying for BUMDES as one of the requirements for obtaining a recommendation from the village head for submission to the Village Ministry. The feasibility analysis employs the AHP method with multiple parameters, including business age, business type, and business capital. According to research findings with applications, several BUMDES are declared unfit, while others are declared feasible. BUMDES with declared eligibility has AHP values ranging from 0.382 to 0.619. Meanwhile, BUMDES that are unworthy receives AHP values ranging from 0.235 to 0.239. It can also be determined based on the weight of each criterion as to whether or not it is appropriate for BUMDES. While the results of black box testing for the system's feasibility using 10 types of testing, including Equivalence Partitioning, Boundary Value Analysis/Limit Testing, Comparison Testing, Sample Testing, Robustness Testing, Behavior Testing, Performance Testing, Requirement Testing, Endurance Testing, and Cause-and-Effect Relationship Testing. Based on the test results, the system is 100% feasible to be used by users.

Keywords*:* BUMDES, AHP, village, *black box*

INTRODUCTION

The movement and development of BUMDES are factors contributing to the economic growth of the nation. Nonetheless, the existence of the BUMDES has never been adequately monitored in terms of the expansion of the business conducted or the addition of the BUMDES in each village.

According to the data, there are 17 BUMDES business units in the Muara District. Due to the difficulty of monitoring the evolution of BUMDES, a significant number of them have become inactive or have even ceased to exist. In addition, many BUMDES managers are frequently unprepared to operate the newly opened business. Readiness in terms of the quality of human resources also affects the formation of BUMDES. Among the village's unsolvable issues are the difficulty in determining a qualified manager and the difficulty in determining a road map. On the other hand, a large number of BUMDES have been formed but have stalled. As a result of a lack of a clear business plan, many people who begin producing goods are unsure how to proceed [1]. At the time of establishing or proposing BUMDES, the establishment process has never been subjected to a feasibility test. This research is conducted in order to facilitate monitoring of business developments carried out by BUMDES actors in their respective villages, thereby facilitating the feasibility evaluation of the proposed BUMDES. With this BUMDES

data collection information system, village officials will find it easier to register BUMDES in each village. And makes it easier to evaluate the viability of BUMDES before registering with the Ministry of Villages' village information system

In BUMDES, numerous problems exist. Many managers do not comprehend the concept and purpose of BUMDES administration. This occurs because the village head perceives his responsibilities as an extension of the government structure above him, which is primarily concerned with administrative issues and those in charge of projects and programs from above. Therefore, it requires considerable effort to comprehend BUMDES, which is more dependent on entrepreneurial issues. The discourse of BUMDES is not well socialized among villagers due to a lack of understanding of BUMDES, so the concept of village development that has been understood thus far is limited to an understanding of physical development and the direction of the structure from above [2]. This has led to numerous BUMDES closures.

This closure occurred due to the absence of a feasibility test prior to the submission of BUMDES. The Village or Subdistrict Head requires this test to determine the readiness of the BUMDES managers who will run their business. This feasibility test can serve as the basis for the Village Head to issue recommendations that are a prerequisite for BUMDES to be uploaded to the village information system at the Ministry of Villages.

Based on the results of research that have been carried out by [3], BUMDES was formed to improve the financial capacity of the village government in carrying out development and community governance, as well as develop the potential and wealth of the village in order to improve the welfare of the community through various community economic business activities according to the needs and potential of the village. The purpose of this study was to determine the management of BUMDES in supporting village economic development, with a case study of BUMDES located in Ngancar District, Kediri Regency. This research is qualitative research. The research sample used purposive sampling with informants included the Community Empowerment Service and Village Government (DPMPD), BUMDES of Sempu Mandiri Management, BUMDES Toyo Makmur Management, BUMDES of Margo Jaya management, BUMDES of Maju Makmur management, BUMDES of Guyub Rukun Management, BUMDES of Sumber Makmur Management, BUMDES of Sumber Agung management, BUMDES of Lancar Sejahtera Management, BUMDES of Karya Mandiri community members who are directly associated with the business units managed by BUMDES.

Researchers employ questionnaires and interviews as data collection methods. The data analysis method used is the qualitative descriptive and analytical hierarchy process (AHP). The research results indicate that the management of each BUMDES has distinct characteristics when it comes to implementing priority indicators. In Ngancar Sub-district, BUMDES serves as the facilitator for the local government, specifically the Community Empowerment and Village Development Office (DPMPD). The existence of BUMDES also contributes to rural community empowerment.

The study is conducted [4] to determine the business feasibility of BUMDES "ARRAHMAN" Lando Village, the village's drinking water supply system unit, both in terms of financial aspects and non-financial aspects, and to find out how much its role in increasing the village's original income was analyzed using percentage calculations. The method used is a qualitative method with a descriptive approach.

Data collection techniques used are interviews, observation, documentation, and forms. This study's data analysis is a non-financial feasibility evaluation based on investment appraisal and percentage analysis.

The results of the non-financial feasibility analysis and the financial feasibility analysis indicate that this village water supply system business is feasible to operate, while the results

of the percentage analysis indicate that this business can contribute to increasing Lando Village's original income.

The difference between this research and previous research is the development of a web application that will be used to conduct a feasibility test for BUMDES actors prior to their registration in the village information system at the Ministry of Villages.

The objective of the feasibility test is to determine whether BUMDES is ready to be proposed in terms of business operating time, business type, and business capital. Once the BUMDES have been determined to be eligible for submission, the village head will issue a recommendation that is necessary for registering BUMDES in the village information system. The web application is also used to monitor the active or inactive BUMDES, in addition to testing its feasibility.

In addition to its economic function, BUMDES also serves a social function. Economic functions and activities involved in the development and management of BUMDES are village businesses that must generate a profit for the village and its community. The social functions that BUMDES can perform are as follows [5]: Indirectly, by providing financial transfers for the village treasury through the addition of Village Original Income (PADesa), which will be used for village development activities with regular village development management mechanisms; and directly, conduct guidance and business assistance carried out by village communities, in addition to managing public goods and services (not private).

METHODS

According to [6], the Analytical Hierarchy Process is a method for solving a complex unstructured situation into several components in a hierarchical arrangement by assigning a subjective value to the relative importance of each variable and determining which variable has the highest priority in order to influence the results.

In accordance with opinion [7], the AHP system can facilitate decision-making in semi-structured and unstructured situations where no one is certain how decisions should be made.

The advantages of the Analytical Hierarchy Process (AHP) over other approaches are as follows: A hierarchical structure as a result of the selected criteria, down to the most fundamental sub-criteria; Consider the validity up to the tolerance limit for the inconsistency of various criteria and alternatives set by decision makers; Take into account the durability or resilience of the decision-making output sensitivity analysis.

The AHP is a decision-support model developed by Thomas L. Saaty. This decision support model will describe a complex multi-factor or multi-criteria problem as a hierarchy, where the first level is the goal, followed by the level of factors, criteria, sub-criteria, etc., and the final level is the alternatives.

Using a hierarchy, a complex problem can be broken down into groups that are then arranged hierarchically so that it appears more structured and organized. According to Saaty, the three primary principles of AHP problem-solving are Decomposition, Comparative Judgment, and Logical Consistency.

In general, the AHP procedure comprises the following steps [8]: The first problem decomposition is the process of systematically describing a predetermined objective as a structure composed of a series of subsystems until the objective can be rationally attained. In other words, a complete objective is broken down (solved) into its component parts.

The second, Assessment/weighting to compare elements if the decomposition process has been completed and the hierarchy is well-structured. Then, on each hierarchy, a pairwise comparison assessment (weighting) is performed. It is assessed (weighted) on each hierarchy based on its relative importance. The third preparation of the matrix and consistency test. If the process of weighting or completing the questionnaire has been completed, the preparation of a paired matrix to normalize the

weight of the importance level for each element in their respective hierarchies is the subsequent step. At this point, the analysis can be performed manually or with an application such as Expert Choice.

Fourth, establishing priorities in each hierarchy for each criterion and alternative necessitates pairwise comparisons. The relative comparison values are then utilized to determine the order of all alternatives based on their relative comparison values. According to a predetermined evaluation, both qualitative and quantitative criteria can be compared to generate weights and priorities. Calculating the weights or priorities involves manipulating a matrix or solving mathematical equations. Last, the synthesis of priorities is obtained by multiplying local priorities by the relevant criteria's priorities at the top level and then adding them to each element at the level affected by the criteria. The result is a combination known as a global priority, which can then be used to assign local priority weights to elements at the lowest level of the hierarchy based on the criteria.

The AHP (Analytic Hierarchy Process) method is a general measurement theory used to determine the ratio scale from discrete and continuous pairwise comparisons. AHP hierarchizes complicated multi-factor or multi-criteria problems. Hirarki didefinisikan sebagai suatu representasi dari sebuah permasalahan yang kompleks dalam suatu struktur multilevel dimana level pertama adalah tujuan, yang Hierarchy is defined as the representation of a complex problem in a multilevel structure, where the first level is the objective, followed by the level of factors, criteria, sub-criteria, etc., until the final level, which is alternatives. Using a hierarchy, a complex problem can be decomposed into groups that are then arranged hierarchically to make it appear more structured and systematic [9]. The stages in the AHP method are as follows: Define the problem and determine the desired solution; Create a hierarchical structure that begins with a general objective, followed by criteria and alternative options.

The AHP method's hierarchical structure is depicted in Figure 1.

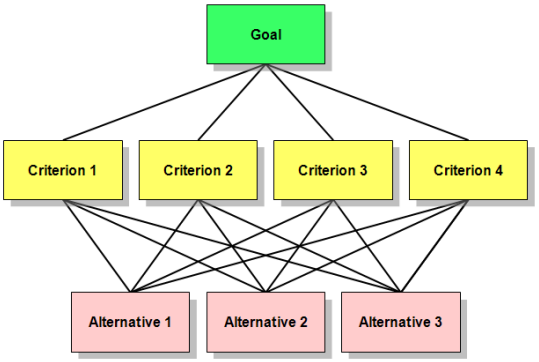

Figure 1, The structure of the AHP method [11]

The calculations using the AHP method are as follows [12]: Create a hierarchy to explain the problem; The weighting of the criteria with AHP is carried out to find out the weighting of the criteria in the hierarchical structure; The stage of the weighting of the sub-criteria involves comparing each sub-criterion to determine the weight of each sub-criterion

This test of consistency determines whether or not the weight values of the criteria are consistent. If it is inconsistent, the calculation or weighting of the criteria will be revised. Calculation of consistency involves calculating the deviation from the value's consistency; the index of consistency is derived from this deviation using the following equation:

$$CI = \frac{\lambda_{max} - n}{n-1} \quad \text{.....(1)}$$

Dimana:

λ_{max}= eigen value maksimum

n = ukuran matriks

Table 1. Random index value (R1)

n	Length of business operation	Type of business	The capital of business
R1	1.12	0.58	0.58

The comparison between CI and RI for a matrix is defined as the consistency ratio,

$$CR = \frac{CI}{RI} \quad \text{.....(2)}$$

The comparison matrix is acceptable if the value of the consistency ratio (CR) ≤ 0.1.

The stage of calculating alternative weights is to determine the weights between alternatives for each sub-criteria. And then combined by multiplying the weights of each criterion, sub-criteria, and option.

The stage of the data analysis aims to determine the prioritized BUMDES obtained from the results of data processing so that the village head can make recommendations to the village ministry. System testing is done using the black box method to determine the system's feasibility before it is used by the user. This test is performed to determine whether the business processes in the application are in accordance with the user's needs analysis and with the input data entered and executed on each application feature.

Black Box Testing is a test that is conducted solely by observing the results of execution through test data and evaluating the software's functionality. This black box test focuses on system functions [10]. According to the Black Box method, there are ten different types of testing: *Equivalence Partitioning*, Dividing the input into data classes that can be used to generate test cases; *Boundary Value Analysis or Limit Testing*, Allowing the selection of test cases to evaluate the input value constraint, the complement of equivalence partitioning; *Comparison Testing*, Ensuring that all versions produce the same output by testing each version with the same data; *Sample Testing,* Involving multiple values selected from an equivalent class; *Robustness Testing*, The purpose of this test is to demonstrate that there is no error if the input is invalid, despite the fact that the input data has been chosen outside of the defined specifications; *Behavior Testing*, The results of the test are unable to be evaluated if the test is only performed once; however, the results are able to be evaluated if the test is performed multiple times; *Performance Testing*, Evaluating the program's ability to operate properly from a reference point of view of needs; *Requirement Testing*, The software's requirements specifications are identified during the requirements specification and design stages; *Endurance Testing*. Requires the repetition of test cases a certain number of times; *Cause – Effect Relationship Testing*, Dividing the requirements specification into parts that have work possibilities.

The design of the application system comprises two parts: the village/sub-district officer side and the user side. The village / sub-district officers have the following responsibilities: Account verification, BUMDES members verification, issessing the feasibility of BUMDES, and BUMDES reports.

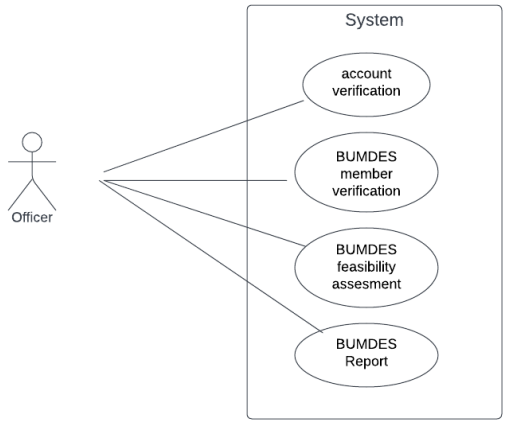

Figure 2. The system design on the village officer side

While on the user side has a role in the system or application including account registration, BUMDES members registration, the input of the BUMDES data, the input of the BUMDES assessment data, and input closure submission for BUMDES.

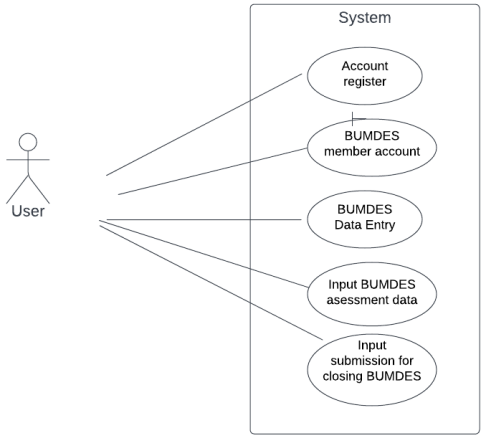

Figure 3. The system design on the user side

A database is also used in the development of the application. In research, the database serves as a data storage medium and also stores the results of the BUMDES feasibility test assessment process. This study's database designs include:

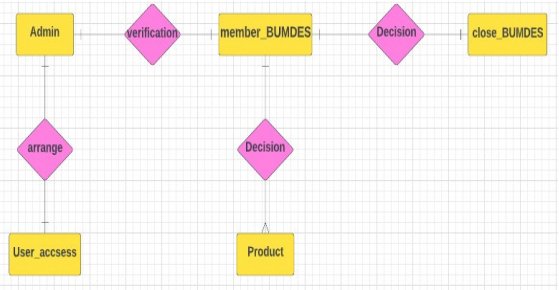

Figure 4. The design of the application database

RESULT AND DISCUSSION

This study employs the AHP technique. As for data processing using AHP, it entails assigning a weight to each criterion and sub-criterion when evaluating the viability of BUMDES. Then, pairwise comparisons will be conducted to determine the priority weight of each criterion.

In this study, the analytic hierarchy process (AHP) method assessment consists of three criteria as follows: Length of business operation, type of business, and the capital of a business

Then, for each of these criteria, the following alternative assessment is made: (1) Length of business operation: 3 months, 6 months, > 6 months < 1 year, 1 year, and > 1 year; (2) Type of business: Small, Medium, and Large; (3) The capital of a business: Small, Medium, and Large. Based on those criteria and alternatives, the value or score of the paired comparison rating scale will be obtained in Table 2. Then, the matrix of criteria value is shown in Table 3. In this matrix, the value of each criterion is calculated to obtain the priority value.

Table 2. The sub-criteria assessment of the length of business operation

The length of business operation	
3 months	0.035
6 months	0.068
> 6 months < 1 year	0.134
1 year	0.260
> 1 year	0.503

After calculating the criterion value matrix, the next step is to determine the consistency ratio by determining the values of CI = consistency index, RI = random index, and CR = consistency ratio. The values can be seen in Table 4.

Table 4. Consistency ratio

CI	0.03	
RI	0.58	
CR	0.05	**Konsisten**

The sub-criteria are then calculated prior to obtain the final AHP value. The results show in Table 5 and Table 6.

Table 5. The sub-criteria assessment of the type of business

Type of business	
Small	0.106
Medium	0.260
Large	0.633

Table 6. The sub-criteria assessment of business capital

Business Capital	
Small	0.106
Medium	0.260
Large	0.633

Table 3. The matrix of criteria value

	Length of business operation	Type of business	The capital of business	Amount	Priority	Eigen Value
Length of business operation	0.111	0.077	0.130	0.318	0.106	0.955
Type of business	0.333	0.231	0.217	0.781	0.260	1.129
The capital of business	0.556	0.692	0.652	1.900	0.633	0.971
Amount	1.000	1.000	1.000	3.000	1.000	3.055

The alternative assessment is a value used as an alternative in determining decisions. The values are shown in Table 7. Then, the results of the AHP calculation are the final step in determining the appropriateness of BUMDES decisions to be submitted for registration with the Ministry of Villages. The values are shown in Table 8.

Table 7. The alternative assessment

Alternative	Business Operation Length	Business Type	Business Capital
A1	6 months	medium	medium
A2	1 year	large	large
A3	3 months	large	small

Table. 8 The AHP assessment

Alternative	Business operation Length	Business Type	Business Capital	Amount	Information
A1	0.007	0.068	0.165	0.240	Not feasible
A2	0.028	0.165	0.401	0.594	Feasible
A3	0.004	0.165	0.067	0.236	Not feasible
			Average value	**0.357**	

The calculation of AHP method implemented in the application will be calculated automatically so as to produce an immediate decision from each assessment to the BUMDES as shown in Figure 5.

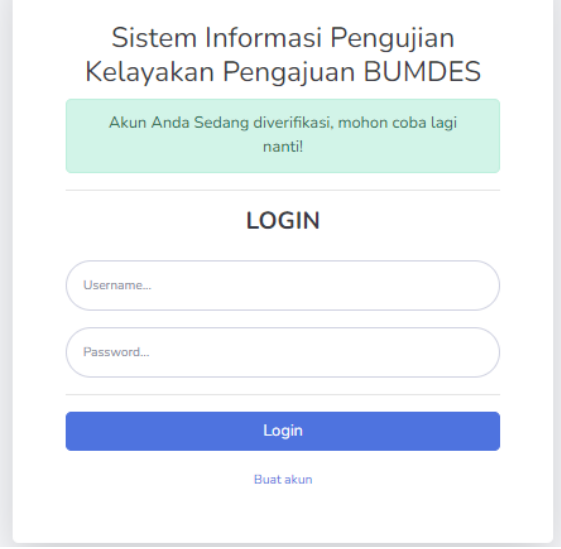

Figure 5. The account operations were not verified by the administrator

The black box testing method is used for system feasibility testing. The following tests are performed to determine the applicability.

A. Equivalence Partitioning

When prospective BUMDES applicants register for account creation, the test is performed. Users cannot access the system if their accounts have not been verified by the administrator. For verified accounts, the user can access the application; however, if the user enters the incorrect password during login, the system will reject the process.

Table 9. Equivalence Partitioning test

Input	Expected Results	Output	Conclusion
Insert: *Username:* hidayat *Password:* hidayat123	The system denies access because the account has not been verified by the administrator.	The system works according to the functions and business processes where the account gives a notification "Your account is being verified, please try again later"	[√] Success [ ] Failure

B. Boundary Value Analysis / Limit Testing

This test verifies that the system or application will not save incomplete data. The test is conducted on the registration feature of the BUMDES member account, in which the data entered is insufficient so when the register button is pressed, the system refuses and the data is not stored in the database.

Table 10. The Boundary Value Analysis/Limit Testing

Input	Expected Results	Output	Conclusion
Insert: Name of owner NIK Address Domicile Business Address Name of BUMDES Phone Number Business operation Length Type of Business Business Capital NPWP Business License Notarial Deel HO TDP Business Location	The system stores data that has been filled in completely into the database	The system rejects the incompletely filled-out data and does not store it in the database.	[√] Success [ ] Failure

C. *Comparison Testing*

This test compares programs that are launched and operated through various browsers. The test results reveal no differences between using the Edge browser or Google Chrome to open the application.

Table 11. Comparison Testing

Input	Expected Results	Output	Conclusion
Applications run on edge browser and google chrome	There is a difference in the appearance of the application when it is run on any browser	The app shows the same result when run on edge and google chrome	[√] Success [ ] Failure

D. *Sample Testing*

This test is carried out to ensure the data entered correctly will be stored in the table and similar to what has been inputted

Table 12. The results of sample testing

Input	Expected Results	Output	Conclusion
Insert Product name Amount Price	The information entered complies with the form and can be properly stored. Additionally, the information displayed matches what was entered.	The application can save the inputted data successfully.	[√] Success [ ] Failure

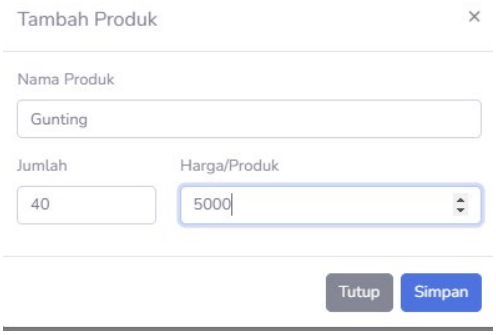

Figure 6. The process of product input on BUMDES member accounts

E. *Robustness Testing*

The test is done by proving the existence of an edit feature on the product input menu to ensure that the data can be edited and stored in the database.

Table 13. The results of the Robustness test

Input	Expected Results	Output	Conclusion
Insert: Edit the data on the product input menu by editing: Product name Amount Price	Edited data can be stored in the database	The application on the product input menu successfully edits the unit price and is successfully stored in the database	[√] Success [ ] Failure

F. Behavior Testing

Testing is performed by repeatedly inserting data based on user input and the result is that the data is successfully stored in the database.

Table 14. The results of Behavior Testing

Input	Expected Results	Output	Conclusion
Insert data of product repeatedly about: Product name Amount Price	The inserted data repeatedly can be stored in the database and the system successfully displays the data	The application is able to store the data of product repeatedly inserted and the data is successfully displayed when the application is run	[√] Success [ ] Failure

G. Performance Testing

This test is done by displaying data according to memory usage and execution speed.

Table 15. The results of performance test

Input	Expected Results	Output	Conclusion
The data is displayed in the form of a graph. The data that appears is in accordance with the input data.	Displaying data with graphs on the dashboard according to data input into the system	The application displays graphical data on the dashboard according to data input	[√] Success [ ] Failure

H. Requirement Testing

This test is conducted to demonstrate the required hardware and software to run the application.

Table 16. The results of requirement testing

Hardware	Database	Programming Language	Testing Method
Processor Intel core i5 Memory 8 GB	Mysql	PHP Framework Codeigniter	The black box method to test the feasibility with 10 types of testing

I. Endurance Testing

The endurance test is performed in the application's calculations to ensure that the calculation process and results are consistent with the created algorithm. This test is carried out by employing the AHP method.

Table 17. The results of the endurance testing

Input	Expected Results	Output	Conclusion
Insert: Data of BUMDES	Displaying the feasibility calculation results for the submission of BUMDES	Displaying the results of the submission feasibility calculation for BUMDES	[√] Success [ ] Failure

J. Cause–Effect Relationship Testing

This test involves editing and deleting application menu conditions. This test ensures that the system on certain menus can be modified or removed.

Table 18. The results of the cause-effect relationship test

Input	Expected Results	Output	Conclusion
Edit and delete in the user settings menu	The application is capable of editing and deleting data	The application displays data and allows for data editing and deletion.	[√] Success [ ] Failure

CONCLUSION

This research provides convenience for village heads in testing the feasibility of BUMDES which will be registered at the Ministry of Villages. Based on the findings of research with applications, it can be seen that several BUMDES are declared ineligible, while others are declared eligible. BUMDES deemed eligible have AHP values between 0.382 and 0.619. The AHP value for BUMDES, which are deemed unworthy, ranges from 0.235 to 0.239. This is also evident from the significance of each criterion in determining the feasibility and

suitability of BUMDES. The feasibility test of the system using the black box method consists of 10 types of testing, including Equivalence *Equivalence Partitioning, Boundary Value Analysis / Limit Testing, Comparison Testing, Sample Testing, Robustness Testing, Behavior Testing, Performance Testing, Requirement Testing, Endurance Testing, dan Cause – Effect Relationship Testing*. The test results show that the system is 100% feasible to use by users.

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