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# Assessment System Of Halal Product Assurance Implementation In Indonesian Companies Using ID3 And Forward Chaining Algorithm

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***Abstract***.
*The majority of the population in Indonesia practices Islam, making halal products important and necessary to meet the rights and needs of Muslim consumers in Indonesia. Therefore, a halal assurance system is required, not only for obtaining halal certification, but also for maintaining continuity in halal production. The existing halal assurance system has been manual, hence the need for an automated computer-based information system that can assess the halal assurance system implemented by companies. This can make it easier and faster for novice users to assess the implementation of halal practices in a company. The ID3 algorithm is used to create decision trees, and the forward chaining algorithm is used for comparison. The web-based system is developed using PHP language and MySQL for data storage. Testing the system by comparing the final results with the manual calculations, as well as using the ID3 and forward chaining algorithms, yields the same results, indicating the successful development of assessment system of halal product assurance. In addition, user satisfaction testing resulted in a score of 87.34%, indicating that users are highly satisfied with the JaminHalal information system.*

***Keywords:*** *Halal, assurance, ID3 and forward chaining.*

## I. INTRODUCTION

Based on data from the Directorate General of Population and Civil Registration of the Ministry of Home Affairs, Indonesia's population is estimated to reach 272.23 million in June 2021. This data indicates that 86.88 percent of Indonesia's total population is Muslim [1]. Therefore, the issue of halal is an important thing that needs to be considered in living a life according to Islamic teachings [2]. This makes the halal assurance assessment system indispensable, considering that every producer must be able to meet the needs and rights of consumers, especially Muslim consumers [3]. The halal assurance system has several functions, including obtaining a halal certificate and maintaining continuity in the halal production process to produce products that are always guaranteed to be halal by the provisions of the LPPOM MUI ( The Assessment Institute for Foods, Drugs, and Cosmetics Indonesian Ulema Council) [3]. In addition, the opportunity demand for the halal industry continues to increase annually by 5.2 percent, and total consumer spending reaches USD 2.2 trillion, which is estimated to continue to increase from time to time [4]. However, the halal assurance system in its application is still not implemented optimally, as evidenced by the results of research conducted by muhlishatin in 2020, which states that there are still business actors who are lazy and don't care about making halal certificates [5]. This process has stages that sometimes take a relatively long and complicated time. A halal certificate is issued by Halal Product Guarantee Agency (BPJPH) and its halal status is determined by the Indonesian Ulema Council (MUI). Therefore, producers need to evaluate the feasibility of obtaining a certificate before submitting to reduce errors in submission, but the system does not yet exist, so there is a need for a feasibility evaluation system to obtain a halal certificate.

Based on research conducted by Sucipto et al. in 2021, which implemented Hierarchical Clustering for a halal assurance system on menu ingredients in the canteen of Universitas Brawijaya, it was concluded that this research can facilitate the identification of complex menu ingredients and can support halal certification using the Hierarchical Clustering method[6].Other research regarding the application of halal guarantees to the industry [7]. However, in this study, no application design was found that could be used to evaluate applications for halal certificates for producers.The system uses the ID3 algorithm because, based on previous research, the use of the ID3 algorithm has the advantage that it can produce values with a high

level of accuracy [8]. In addition, ID3 is completely accurate in classifying data because the learning process results on the training data are in the form of a decision tree [9]. Hence, the calculation process has high accuracy because the classification is done using inference to the obtained decision tree rules [9]. Therefore, the decision tree obtained can be used as a reference in classifying the halal assurance system assessment. The Decision Tree method, of which ID3 is a part, has a direct interpretation of the results, which makes this method usable for classification and prediction [10].

As a comparison algorithm, the forward chaining algorithm is used. This algorithm starts by examining the data presented as input, and the data will be processed according to predefined rules to reach a conclusion. Forward chaining can also be referred to as bottom-up reasoning [11]. This name can be observed from the method used, where the initial considerations come from the facts at the bottom, and from these facts, conclusions are reached at the top.The assessment system of halal product assurance halal assurance system has the advantage of creating a more systematic system because until now, the evaluation of the halal assurance system still uses the manual method, from data collection to assessment. In addition, the establishment of this system can have a positive impact on users [9]. They can find out whether users or business actors have implemented the halal assurance system well and meet the requirements to apply for halal certification according to the provisions of LPPOM MUI because users can simulate halal assurance assessments independently. In a brief application, this system will provide several questions as important assessment aspects according to the criteria from LPPOM-MUI, and users can fill them out independently. After the answers are collected, it will be processed by the system that has been created to generate a score of whether the user's business has met the halal assurance criteria and is eligible to apply for a halal certificate. It is hoped that with this system, the halal quality of every business actor can be maintained and support the rights of consumers, especially Muslim consumers.

## II. METHODS

The system is made following the stages of the software Waterfall Development Life Cycle (SDLC) method so that the implementation process is more organized and orderly [12].

1. Requirements
   This stage aims to collect the necessary data and information [13] related to the halal assurance system and performance evaluation of the halal assurance system implementation in companies that hold MUI halal certificates. The primary source of data will be documents obtained from LPPOM - MUI, East Kalimantan Province, specifically document number 3/SJH/LP-POMMUI KT.
2. Design
   At this stage, planning is carried out for all the requirements needed in making the application, including making the structure and interface display based on the needs of making a halal assurance system. System design includes creating business processes, data flow diagrams (DFD), Entity Relation Diagrams (ERD) and data table structures.
3. Programming using PHP, javascript and MySQL database.
4. The testing is using blackbox testing [14] and user acceptance testing.

## III. RESULT AND DISCUSSION

### *ID3 Algorithm*

ID3 calculation is carried out in two stages. In the first stage, perform calculations to find companies with a pass or fail score with a "C" score. In the second stage, if the company gets a passing grade, a re-calculation will be carried out to determine whether the company passed by getting an "A" or "B" grade.

1. First ID3 calculation: Table 1 is an example of dataset that was created and collected based on the possibilities that could occur during and assessment of the halal assurance system based on the Guidelines for Performance Assessment of the Implementation of the Halal Assurance System in Companies Holding MUI Halal Certificates issued by the Research Institute for Food, Medicine - Medicines and Cosmetics Indonesian Ulema Council (LPPOM – MUI) East Kalimantan Province with document number 3/SJH/LPPOMMUI KT. The ten components used as a reference in the evaluation

are divided into two parts: the main element, which includes the Halal Management Organization, Administration and Documentation, Storage, Materials and Production Processes, and Product Performance. Other components that support the assessment include Technical Reference for Halal Implementation, Halal Communication, Training and Socialization, Internal Audit and Reports, and Management Review

**Table 1.** Example of dataset.

| No | Assessment Component | Value | | | Value for each Component |
|---|---|---|---|---|---|
| | | *A (3)* | *B (2)* | *C (1)* | |
| I | Halal Management Organization (K1) | | | | |
| | 1.1. Halal Responsible Position | X | | | 14/5 = 2,8 ≈ 3 |
| | 1.2. Halal Responsible Religion | X | | | (A) |
| | 1.3. Material and process knowledge | | X | | |
| | 1.4. Authority | X | | | |
| | 1.5. Legality | X | | | |
| II | Technical Reference for the Implementation of Halal Assurance System (K2) | | | | |
| | 2. 1. Halal Assurance System Manual | X | | | 11/5 = 2,2 ≈ 2 |
| | 2. 2. Halal Product Reference | | | X | (B) |
| | 2. 3. List of Materials known to LPPOM MUI | X | | | |
| | 2. 4. Standard Formula/Recipe | | X | | |
| | 2. 5. Table of determination of critical points for materials and processes | | X | | |
| III | Administration and Documentation (K3) | | | | |
| | 3. 1. Material Purchase Administration | | X | | 5/4 = 1,25 ≈ 1 |
| | 3. 2. Administration of Material/Formula Changes | | | X | (C) |
| | 3. 3. Administration of Receiving and Storage | | | X | |
| | 3. 4. Documentation | | | X | |
| IV | Storage (K4) | | | | |
| | 4. 1. Storage of production materials | X | | | 9/3 = 3 |
| | 4. 2. Storage of production equipment | X | | | (A) |
| | 4. 3. Product storage | X | | | |
| V | Materials and Production Process (K5) | | | | |
| | 5. 1.Use of production materials | | X | | 8/3 = 2,67 |
| | 5. 2.Use of formula/recipe | X | | | (A) |
| | 5. 3.Production facilities and processes | X | | | |
| | 5. 4.Manufacturing fee I | | | | |
| | 5. 5.Manufacturing fee II | | | | |
| VI | Product Performance (K6) | | | | |
| | 6. 1.Halal label/logo | | X | | 5/2 = 2,5 |
| | 6. 2.Product Distribution/Display | X | | | (A) |
| VII | Communication (K7) | X | | | 3 (A) |
| VIII | Halal Training and Socialization (K8) | | X | | 2 (B) |
| IX | Internal audit and reports (K9) | | | X | 1 (C) |
| X | Management Review (K10) | | | X | 1 (C) |
| | STATUS CUMULATIVE VALUE (Halal Assurance System Status) | | | | (B) |

Table 2 is the dataset that will be used as data to perform initial calculations to obtain entropy and gain values, aiming to get rules that will be used as a reference in system implementation. The dataset contains two categories: "Number of principal components with each value of A-B $\geq$ 5" and "Number of other components with each value of A-B $\geq$ 2", With the condition that both are met, it will be declared as passing.

**Table 2.** Two categories in dataset for first calculation.

| No | The number of principal components with each value A-B $\geq$ 5 | The number of other components with each value A-B $\geq$ 2 | Results |
|---|---|---|---|
| 1 | 5 | 3 | PASS |
| 2 | 5 | 2 | PASS |

| | | | |
|---|---|---|---|
| 3 | 4 | 5 | FAIL (C) |
| 4 | 1 | 4 | FAIL (C) |
| 5 | 5 | 4 | PASS |
| 6 | 5 | 1 | FAIL (C) |
| 7 | 4 | 4 | FAIL (C) |
| 8 | 3 | 4 | FAIL (C) |
| 9 | 5 | 5 | PASS |
| 10 | 4 | 3 | FAIL (C) |
| 11 | 3 | 5 | FAIL (C) |
| 12 | 2 | 2 | FAIL (C) |
| 13 | 1 | 5 | FAIL (C) |
| 14 | 2 | 4 | FAIL (C) |

Table 3 is the calculation of entropy and gain in the first calculation of the dataset. Calculations for each attribute for each category. Furthermore, after all entropy values are obtained, the gain calculation is performed for each category. Then the highest gain value is selected for the node 1 value, namely the category "Number of main components with each value A-B ≥ 5 with a value 0.605.

**Table 3.** Calculation of entropy and profit in the first calculation.

| | NODE 1 | | | | | |
|---|---|---|---|---|---|---|
| | **Desc** | **Total** | **Pass** | **Fail (C)** | **Entropy** | **Obtain** |
| Total | | 14 | 4 | 10 | 0.863 | |
| The number of principal components with each value A-B ≥ 5 | 5 | 5 | 4 | 1 | 0.721 | |
| | 4 | 3 | 0 | 3 | 0 | |
| | 3 | 2 | 0 | 2 | 0 | 0.605 |
| | 2 | 2 | 0 | 2 | 0 | |
| | 1 | 2 | 0 | 2 | 0 | |
| The number of other components with each value A-B ≥ 2 | 5 | 4 | 1 | 3 | 0.811 | |
| | 4 | 5 | 1 | 4 | 0.721 | |
| | 3 | 2 | 1 | 1 | 1 | 0.087 |
| | 2 | 2 | 1 | 1 | 1 | |
| | 1 | 1 | 0 | 1 | 0 | |

Table 4 is a sorted dataset based on the category with the highest node value from the previous entropy and gain calculations. The highest gain value is obtained from the category "Number of main components with each value A-B ≥ 5". Therefore, the dataset is sorted by category with the highest gain value.

**Table 4.** Dataset after shortening.

| **No** | **The number of principal components with each value A-B ≥ 5** | **The number of other components with each A-B ≥2** | **Results** |
|---|---|---|---|
| 1 | 5 | 3 | PASS |
| 2 | 5 | 2 | PASS |
| 3 | 5 | 4 | PASS |
| 4 | 5 | 1 | FAIL (C) |
| 5 | 5 | 5 | PASS |
| 6 | 4 | 3 | FAIL (C) |
| 7 | 4 | 5 | FAIL (C) |
| 8 | 4 | 4 | FAIL (C) |
| 9 | 3 | 4 | FAIL (C) |
| 10 | 3 | 5 | FAIL (C) |
| 11 | 2 | 2 | FAIL (C) |
| 12 | 2 | 4 | FAIL (C) |
| 13 | 1 | 5 | FAIL (C) |
| 14 | 1 | 4 | FAIL (C) |

Figure 1 represents rules that are formed from the results of previous calculations of entropy and gain, as well as from the results of previous dataset sorting to determine the acquired rules. If the category "Number of main components with each" with a value of A-B ≥ 5 is less than 5, the system categorizes it as a fail or receives a grade of "C". However, if it has a value of 5, it will proceed to the next matching, which is if the category "Number of other components with each" with a value of AB ≥ 2 is less than 2, the system categorizes it as a fail or receives a grade of "C". But if it has a value greater than 2, the system will categorize it as a pass and continue to the second ID3 calculation.

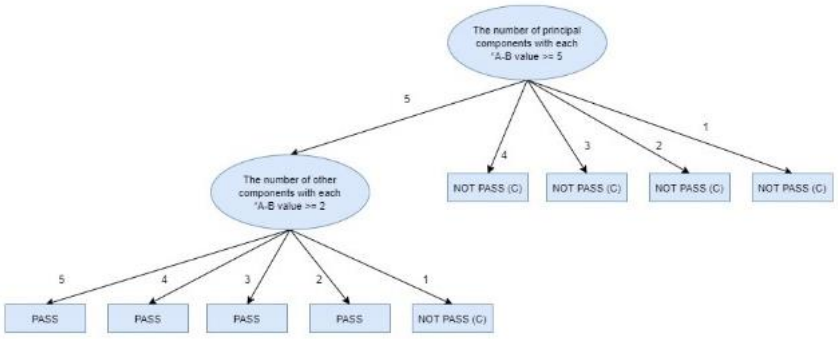


**Fig 1**.First Calculation Rule

2. Second ID3 Calculation: In Table 5, it is a dataset used for the second calculation. This dataset consists of two categories, namely the category "Number of Main Components = A" and the category "Number of Other Components with Each" with a value of A-B ≥ 2". The dataset is created and collected based on the possibilities that may occur during the assessment of the halal assurance system, according to the Guidelines for Performance Assessment of Halal Assurance System.

**Table 5.** Dataset for second calculation.

| No | Number of principal components = A | The number of other components with each value A-B ≥ 2 | Results |
|---|---|---|---|
| 1 | 5 | 5 | A |
| 2 | 5 | 4 | A |
| 3 | 5 | 3 | A |
| 4 | 5 | 2 | B |
| 5 | 4 | 5 | B |
| 6 | 4 | 2 | B |
| 7 | 3 | 4 | B |
| 8 | 3 | 3 | B |
| 9 | 2 | 5 | B |
| 10 | 2 | 3 | B |
| 11 | 1 | 4 | B |
| 12 | 1 | 2 | B |
| 13 | 0 | 5 | B |
| 14 | 0 | 2 | B |

In Table 6, calculations are carried out to obtain entropy and gain values in the second calculation. In the calculation, first, the calculation is done for each attribute owned by each category, namely the category "Number of Main Components = A" and the category "Number of Other Components with Each" with a value of A-B ≥ 2". After all the attributes have been calculated, the entropy calculation is continued for each attribute that has been previously recorded. After obtaining all the entropy values, the gain calculation is then performed for each category available. Once all the gain values are found, the one with the highest gain value is chosen as the value for node 1, which is the category "Number of Main Components = A" with a value 0.517.

**Table 6.** Calculation of entropy and profit in the second calculation.

| | NODE 1 | | | | | |
|---|---|---|---|---|---|---|
| | Des | Total | A | B | Entropy | Obtain |
| Total | | 14 | 3 | 11 | 0.749 | |
| Number of principal components = A | 5 | 4 | 3 | 1 | 0.811 | |
| | 4 | 3 | 0 | 2 | 0 | |
| | 3 | 2 | 0 | 2 | 0 | 0.517 |
| | 2 | 2 | 0 | 2 | 0 | |
| | 1 | 2 | 0 | 2 | 0 | |
| The number of other components with each "AB value >= 2 | 5 | 4 | 1 | 3 | 0.811 | |
| | 4 | 3 | 1 | 2 | 0.918 | |
| | 3 | 3 | 1 | 2 | 0.918 | 0.124 |
| | 2 | 4 | 0 | 4 | 0 | |

Table 7 is a dataset sorted by category with the highest node value from the previous entropy and gain calculations. The last calculation gets the highest gain value from the "Total Main Components = A" category. Therefore, the dataset is sorted by category with the highest gain value.

**Table 7.** Second calculation dataset after shorting.

| No | The number of principal components = A | The number of other components with each value A-B ≥ 2 | Results |
|---|---|---|---|
| 1 | 5 | 5 | A |
| 2 | 5 | 4 | A |
| 3 | 5 | 3 | A |
| 4 | 5 | 2 | B |
| 5 | 4 | 5 | B |
| 6 | 4 | 2 | B |
| 7 | 3 | 4 | B |
| 8 | 3 | 3 | B |
| 9 | 2 | 5 | B |
| 10 | 2 | 3 | B |
| 11 | 1 | 4 | B |
| 12 | 1 | 2 | B |
| 13 | 0 | 5 | B |
| 14 | 0 | 2 | B |

In figure 2, the rules are formed from the results of previous calculations of entropy and gain, as well as from the results of previous dataset sorting to determine the acquired rules. If the category "Number of Main Components = A" has a value less than 5, the system categorizes it as a pass with a grade of "B". However, if it has a value of 5, it will proceed to the next matching, which is if the category "Number of Other Components with Each" with a value of A-B ≥ 2 is less than 3, the system categorizes it as a pass with a grade of "B". But if it has a value greater than 3, the system will categorize it as a pass with a grade of "A".

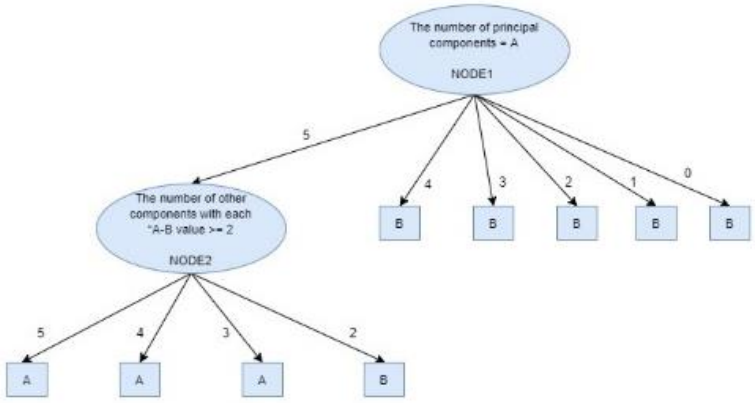


**Fig 2.**Second calculation rule

***Forward chaining***

To determine the performance assessment of the halal assurance system, some questions will be used, taken from the assessment guideline document of the Food, Drug, and Cosmetic Assessment Agency of the Indonesian Ulama Council (LPPOM MUI) East Kalimantan with document number 3/SJH/LPPOMMUI KT. As an example only one component is taken, Halal Management Organization and then is made the questions.

- Is the internal halal auditor an owner or permanent employee?
- Is the auditor a Muslim?
- Does the auditor have adequate knowledge of critical points of materials and processes?
- Does the auditor have the authority to take necessary actions to implement the Halal Assurance System (SJH) in accordance with the rules set by LPPOM MUI?"
- Is the legality of the auditor supported by a Company Decree (SK)?

For the performance assessment of the halal assurance system itself, there are ten assessment components divided into two parts, namely five main components and five supporting components. The five main components and the other five supporting components are used. The assessment system will generate

three possible final scores, namely A or Good, B or Sufficient, or C or Insufficient, if the criteria for a B score are not met. The questions are divided into several components. The scoring used for each question is A worth 3 points, B worth 2 points, and C worth 1 point. The scores obtained for each question in each component will be averaged and rounded. Based on the scores obtained for each component, where each component is categorized as either a main component or a supporting component, the final score will be calculated using a decision tree (Figure 3).

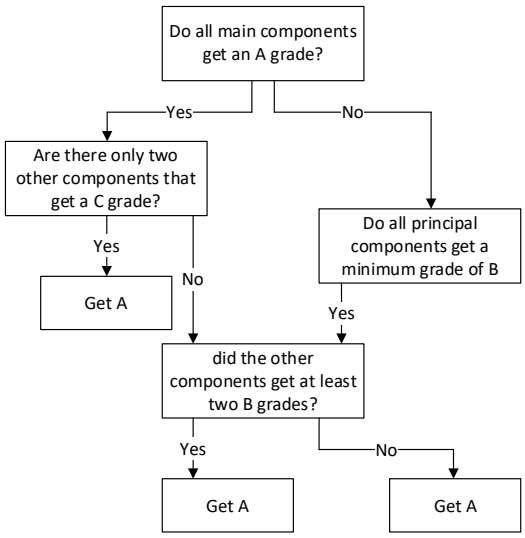


**Fig 3.** Decision tree for final score

The system will gather information about which parts are considered main components and which are considered supporting components, and fill in the initial value of A (3) as the final value. After that, the final values obtained for each main component will be evaluated, and if any main component receives a score less than 3, the temporary final value will be changed to B (2). If the temporary final value is still A (3), then it will continue to the second part as seen in code 4.2, where if there are only a maximum of two supporting components with a value of C (1), then the final value will not change. If this condition is not met, then the temporary final value will change to B (2). If the temporary final value is B (2), then it will proceed to the third part to determine the final value. If all main components receive a minimum value of B (2), then further checks will be conducted for the supporting components. However, if this condition is not met, then the final value will be set to C (1). For the evaluation of supporting components, it will be checked whether there are at least three supporting components that receive a value of B. If this condition is met, the final value will be set to B (2), and if it is not met, the final value will be set to C (1)

***Testing ID3 algorithm***

System testing is carried out by testing the assessment of the halal assurance system using manual calculations with the results of calculations through the halal assurance system that has been built. In Table 8, the data will be used as a test data to compare the results of manual calculations with the results of the halal assurance system that has been built.

**Table 8.** Data training.

| No Problem | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | K9 | K10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 1 |
| 2 | 1 | 1 | 3 | 1 | 3 | 2 | | | | |
| 3 | 3 | 1 | 2 | 3 | 3 | | | | | |
| 4 | 3 | 2 | 1 | | 1 | | | | | |
| 5 | 3 | 2 | | | 1 | | | | | |

1. Manual Calculation Trial: Manual system testing is carried out by calculating values based on components, then categorizing the main features and other components, and adjusting the scoring scheme determined by LPPOM – MUI (Tabel 9 and 10).

**Table 9.** Manual calculation based on each component.

| Category | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | K9 | K10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total value | 2.6 | 1.8 | 2 | 1.6 | 2.2 | 2.5 | 1 | 3 | 2 | 1 |
| Score | A | B | B | B | B | A | C | A | B | C |

**Table 10.** Manual calculation based on each component.

| Score | Reach |
|---|---|
| A | 3 – 2.5 |
| B | 2.4 – 1.5 |
| C | 1.4 - 0 |

**Table 11.** Final Grade Category.

| Score | Supply | |
|---|---|---|
| A (Good) | 5 Main Components worth = A | X |
| | Other Components with a maximum of 2 get a C . value | V |
| B (Average) | 5 Principal Component Value = A/B | V |
| | Other components of at least 2 get a B . value | V |
| C (Deficient) | Does not meet criteria B | X |

After manually calculating, letter grades were obtained for each component. Next, based on Table 11, categorization was done to obtain the final score for the tested data. According to the predetermined criteria, the final score obtained was consistent with the manually calculated result, which is a "B (Satisfactory)" grade.

2. Halal Assurance System Trial: The trial was conducted using the same test data as the data used for manual calculation trials in Table 8.

**Table 12.** Final Grade Category.

| K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | K9 | K10 |
|---|---|---|---|---|---|---|---|---|---|
| A | B | B | B | B | A | C | A | B | C |

Table 12 shows the value of each component. After the calculation procedure, the value of each element is found, as shown in Tabel 12. These values will be processed by the system based on predefined rules. The test shows the system and manual results are the same.

***Testing forward chaining algorithm***

Testing is done by comparing manual calculations with the system for several test cases. The test results show that the manual and system tests are the same.

***System evaluation***

System evaluation is carried out by conducting a user satisfaction test by distributing surveys using Google forms to 30 respondents because the number of respondents who are eligible to conduct research is as many as 30 to 500 samples [15]. In distributing the questionnaire, using a Likert scale and questions based on the Technology Acceptance Model (TAM) [16] with 5 assessment categories, namely Perceived Ease of Use, Perceived Usefulness, Attitude To Use, Behavioral Intention To Use, and Actual System Use. The percentage value of user satisfaction in using the system was 87.34%, which shows that halal assurance assessment system has succeeded in facilitating the assessment of the halal assurance system for its users.

***Discussion***

System implementation is influenced by many factors, among others are described:

- The accuracy of the system in classifying company classes is very important. This should be further evaluated based on the system's ability to identify and classify.
- System efficiency in terms of processing time and resource utilization should be assessed. The system must be able to process data in a timely manner without undue delay, and not consume excessive computational resources. The evaluation should consider the system's performance in handling large data sets and its response time in delivering results.
- The effectiveness of the system in achieving its intended goals must be evaluated. The system must be able to accurately assess the conformity of the classification with Halal guidelines and requirements,

and provide reliable and consistent results. The evaluation must assess whether the output of the system is in line with the actual status.

- The robustness of the system in dealing with uncertainty, error, and variation in data must be evaluated. The system must be able to handle missing, incomplete, or inconsistent data, and provide reliable results despite the uncertainty and errors in the input data. The evaluation should assess the system's ability to handle multiple scenarios and variations.

## IV. CONCLUSION

Based on the research, an information system for assessing halal assurance with the previously designed ID3 and forward chaining algorithm have been successfully built. Blackbox testing[16] compares manual calculations and the system which produces the same results. This indicates the implementation of the system is correct. In addition, after carrying out a comparative test between the system and the ID3 algorithm with the forward chaining algorithm with 2 different trial data, the final values were the same, indicating that the assessment of the halal assurance system carried out using the ID3 algorithm was appropriate. Based on this test, the system can find out whether business actors have properly implemented the halal assurance system and are eligible to apply for halal certification according to the provisions of LPPOM MUI with accurate results. After analyzing thirty respondents using the Technology Acceptance Model (TAM) and the Likert scale, it was found that the percentage of system success was 87.34% which indicated that users of the system were satisfied with using the information system. For further research, we recommend using two or three data mining techniques so that we can compare which technique produces the most accurate predictions and which technique is the most suitable.

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