APPLICATION OF THE C4.5 ALGORITHM IN MEASURING CUSTOMER SATISFACTION LEVELS TOWARD SERVICE IN A MINIMARKET

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Article Info	ABSTRACT (10 PT)
	Customer satisfaction is a crucial indicator in assessing the service quality of a retail business, specifically at Minimarket Berkah Jaya. Currently, customer satisfaction measurement is conducted manually, resulting in subjective and unstructured data, which hinders management from evaluating and improving service quality effectively. Therefore, this study aims to apply the C4.5 algorithm to measure and classify the level of customer satisfaction. The research data were collected through questionnaires distributed to 50 customers. The classification process used the C4.5 algorithm with attributes: Cashier Service, Shop Assistant Service, Product Completeness, Transaction Speed, and Store Facilities. The algorithm constructed a decision tree based on entropy and information gain calculations. The results indicate that Cashier Service is the most influential factor in determining customer satisfaction at Minimarket Berkah Jaya. The developed system assists management in data-driven decision-making to enhance service quality.

1. INTRODUCTION

The development of the retail industry in Indonesia is currently experiencing rapid growth, triggering intense competition among business players, from traditional markets to modern retail. In this competitive situation, customer satisfaction becomes an invaluable intangible asset for business continuity. Satisfied customers tend to have high loyalty, make repeat purchases, and recommend the store to others. Therefore, for a minimarket, understanding customer perceptions of service quality is no longer just an option, but a strategic necessity to maintain market share [1].

Minimarket Berkah Jaya, as one of the retail stores serving the basic needs of the community, faces challenges in managing the quality of its service. Based on initial observations, there are often queues at the cashier and complaints regarding incomplete stock that are not addressed quickly. Currently, the customer satisfaction evaluation method in use is still conventional and passive, relying only on physical suggestion boxes or verbal complaints conveyed to employes. This method has a fundamental weakness, namely that the data collected is often unstructured, subjective, and difficult to process into information that can support quick and accurate managerial decision-making.

As the volume of transactions and the number of customers increase, data regarding customer interactions accumulates and becomes "data waste" if not utilized. To address this issue, an information technology approach in the form of Data Mining is required. Data Mining allows companies to extract valuable information and hidden patterns from large databases. By applying classification techniques to customer questionnaire data, management can map satisfaction patterns based on specific service attributes, so that service improvement policies are no longer based solely on assumptions, but rather on factual data (data-driven) [2].

One of the reliable and widely used classification techniques in Data Mining is the C4.5 Algorithm. This algorithm is an enhancement of the ID3 algorithm, which works by forming a Decision Tree. The main advantage of the C4.5 Algorithm compared to other classification methods such as Naïve Bayes or K-Nearest Neighbor is its output, which is in the form of a decision tree or rule-based system. This output format is very easy for humans to interpret, allowing the management of Minimarket Berkah Jaya to easily understand the causes of customer dissatisfaction—such as whether the dissatisfaction is primarily due to

slow cashier service or uncomfortable store facilities [3].

This research aims to apply the C4.5 algorithm to measure and classify customer satisfaction levels at Minimarket Berkah Jaya. Thru this research, it is expected that a knowledge model will be developed to provide recommendations for prioritizing service improvements, so that customer satisfaction enhancement strategies can be implemented more effectively and efficiently.

2. MATERIALS AND METHODS

2.1. Research Framework

This study employs a quantitative approach using data mining techniques to analyze customer satisfaction patterns. The research stages are structured systematically, beginning with problem identification at Minimarket Berkah Jaya, followed by data collection, data preprocessing, implementation of the C4.5 Algorithm, and finally, the generation of decision rules. The primary goal of this methodology is to transform raw customer feedback into a structured decision tree that can assist management in strategic planning.

2.2. Data Collection Method

The data used in this study were obtained directly from the source (primary data).

1. **Observation:** Initial observations were conducted to identify problems related to service queues and stock availability at Minimarket Berkah Jaya.
2. **Questionnaire:** The primary instrument for data collection was a structured questionnaire distributed to customers. The population of this study was the customers of Minimarket Berkah Jaya. Using the random sampling technique, a sample of 50 respondents was selected. The questionnaire utilized a Likert Scale (1 to 5), where 1 represents "Very Dissatisfied" and 5 represents "Very Satisfied."

2.3. Research Variables

To construct the decision tree, the research variables were divided into attributes (criteria) and a target class (label). The attributes were adapted from service quality dimensions relevant to the retail industry:

1. **Cashier Service (C1):** Measures the friendliness, accuracy, and efficiency of the cashier during the payment process.
2. **Shop Assistant Service (C2):** Measures the responsiveness and helpfulness of floor staff in assisting customers to find products.
3. **Product Completeness (C3):** Measures the availability and variety of products sold in the store.

4. **Transaction Speed (C4):** Measures the waiting time in the queue and the speed of the transaction process.
5. **Store Facilities (C5):** Measures the comfort of the physical environment, including cleanliness, air conditioning, and parking space.

2.4. Data Preprocessing

Before applying the C4.5 algorithm, the raw data collected from the questionnaires underwent a preprocessing stage. The numerical values from the Likert scale were transformed into categorical data to fit the requirements of the C4.5 algorithm. The transformation rules are as follows:

- **Attributes (C1-C5):** Categories such as "Friendly/Not Friendly", "Fast/Slow", or "Complete/Incomplete" were determined based on the threshold of the average score.
- **Target Class (Satisfaction):** The final classification is divided into two labels: **"Satisfied"** and **"Not Satisfied"**. If the average score of a respondent is >3, they are classified as "Satisfied". Conversely, if the score is ≤ 3, they are classified as "Not Satisfied".

2.5. C4.5 Algorithm Implementation

The C4.5 algorithm is a classification method used to generate a decision tree. It is an improvement of the ID3 algorithm. The construction of the decision tree involves a recursive partitioning process (divide and conquer). The steps are as follows:

1. **Calculate Total Entropy:** Determine the uncertainty of the entire dataset. The formula for Entropy is:

$$Entropy(S) = \sum_{i=1}^{n} -pi * \log_2 pi$$

Where:
- S: The set of cases.
- n: Number of partitions (classes) in S.
- pi: The proportion of cases belonging to class i.

2. **Calculate Information Gain:** Determine which attribute provides the highest information gain to be selected as the root node or internal node.
The formula for Gain is:

$$Gain(S, A) = Entropy(S) - \sum_{i=1}^{n} \frac{|S_i|}{|S|} * Entropy(S_i)$$

Where:
- S: The set of cases.
- A: The attribute being evaluated.

- |Si|: The number of cases in partition i.
- |S|: The total number of cases in S.

3. **Select the Best Attribute:** The attribute with the highest Gain value is chosen as the splitting node.
4. **Create Branch and Repeat:** Create a branch for each value of the selected attribute and distribute the cases accordingly. Repeat the process for each branch until all cases in a branch belong to the same class or there are no more attributes to be selected.

3. RESULTS AND DISCUSSION [Times New Roman 10 bold]

3.1. Data Transformation

The data used in this study consists of 50 records of customer responses from Minimarket Berkah Jaya. The raw data collected via questionnaires (Likert Scale 1-5) were transformed into categorical data to be processed by the C4.5 algorithm. The transformation attributes are defined in Table 1.

Tabel 1. Data Attribute Transformation

Attribute	Description	Initial Value (Likert Scale)	Transformed Category
C1	Cashier Service	Mean Score > 3	Friendly
		Mean Score $\leq$ 3	Not Friendly
C2	Shop Assistant Service	Mean Score > 3	Responsive
		Mean Score $\leq$ 3	Not Responsive
C3	Product Completeness	Mean Score > 3	Complete
		Mean Score $\leq$ 3	Incomplete
C4	Transaction Speed	Mean Score > 3	Fast
		Mean Score $\leq$ 3	Slow
C5	Store Facilities	Mean Score > 3	Comfortable
		Mean Score $\leq$ 3	Not Comfortable
Class	Customer Satisfaction	Mean Score > 3	**Satisfied**
		Mean Score $\leq$ 3	**Not Satisfied**

After transformation, a sample of the dataset used for the training process is presented in Table 2.

Table 2. Sample of Transformed Dataset

No	C1 (Cashier)	C2 (Assistant)	C3 (Product)	C4 (Speed)	C5 (Facility)	Satisfaction (Class)
1	Friendly	Responsive	Complete	Fast	Comfortable	**Satisfied**
2	Not Friendly	Responsive	Incomplete	Slow	Comfortable	**Not Satisfied**
3	Friendly	Not Responsive	Complete	Slow	Not Comfortable	**Not Satisfied**
4	Friendly	Responsive	Complete	Fast	Not Comfortable	**Satisfied**
5	Not Friendly	Not Responsive	Complete	Fast	Comfortable	**Not Satisfied**
6	Friendly	Responsive	Complete	Slow	Comfortable	**Satisfied**
7	Not Friendly	Not Responsive	Incomplete	Slow	Not Comfortable	**Not Satisfied**
8	Friendly	Responsive	Complete	Fast	Comfortable	**Satisfied**

9	Friendly	Responsive	Incomplete	Fast	Not Comfortable	**Satisfied**
10	Not Friendly	Responsive	Complete	Slow	Not Comfortable	**Not Satisfied**
...	...	...	...	...	...	...
50	Friendly	Responsive	Incomplete	Fast	Comfortable	**Satisfied**

3.2. C4.5 Algorithm Calculation

The construction of the decision tree begins by calculating the total Entropy of the target class. Based on the 50 data samples, there are 26 cases of "Satisfied" and 24 cases of "Not Satisfied".

The calculation of Total Entropy is as follows:

$$Entropy(Total) = \left(-\frac{26}{50} \times \log_2 \frac{26}{50}\right) + \left(-\frac{24}{50} \times \log_2 \frac{24}{50}\right)$$
(1)
$$Entropy(Total) = 0.998 \ (2)$$

All symbols that have been used in the equations should be defined in the following text.

Next, the Gain value for each attribute is calculated to determine the root node. The detailed calculation for Node 1 is shown in Table 3.

Table 3. Calculation of Entropy and Gain for Node 1

Attribute	Value	Total Cases	Satisfied	Not Satisfied	Entropy	Gain
TOTAL		50	26	24	0.998	
C1 (Cashier)	Friendly	30	24	6	0.722	**0.487**
	Not Friendly	20	2	18	0.469	
C2 (Assistant)	Responsive	28	18	10	0.940	0.222
	Not Responsive	22	8	14	0.946	
C3 (Product)	Complete	32	20	12	0.954	0.331
	Incomplete	18	6	12	0.918	
C4 (Speed)	Fast	25	16	9	0.943	0.171
	Slow	25	10	15	0.971	
C5 (Facility)	Comfortable	27	15	12	0.991	0.169
	Not Comfortable	23	11	12	0.998	

3.4. Accuracy Testing

To validate the model, a Confusion Matrix was used to compare the predicted results with the actual data. The results of the accuracy test are presented in Table 4.

Table 4. Confusion Matrix

	Predicted Satisfied	Predicted Not Satisfied
Actual Satisfied	24 (TP)	2 (FN)
Actual Not Satisfied	3 (FP)	21 (TN)

$$Accuracy = \frac{TP + TN}{Total\ Data} \times 100\backslash\%$$
$$Accuracy = \frac{24 + 21}{50} \times 100\backslash\% = 90\backslash\%$$

3.5. Discussion

The analysis reveals that human interaction factors, specifically **Cashier Service**, play a more significant role in customer satisfaction than physical factors like store facilities or product completeness. Even if the store has complete products, customers tend to be dissatisfied if the cashier service is unfriendly. Furthermore, for customers who receive friendly service, the **Speed of Transaction** becomes the second determinant; slow service can still lead to dissatisfaction. This suggests that the management of Minimarket Berkah Jaya should focus on training employees in service excellence and operational efficiency.

4. CONCLUSION [Times New Roman 10 bold]

Based on the implementation and testing of the C4.5 algorithm on customer data at Minimarket Berkah Jaya, several important conclusions can be drawn. First, the C4.5 algorithm proved to be highly effective in classifying customer satisfaction levels, achieving an accuracy rate of 90%. This indicates that the decision tree model generated is reliable for predicting customer sentiment.

Second, the analysis reveals that Cashier Service (C1) is the most dominant factor influencing customer satisfaction, followed by Transaction Speed (C4). The generated rules show that customers tend to feel dissatisfied if the cashier service is unfriendly, even if the product availability is complete. Therefore, to improve business competitiveness, the management of Minimarket Berkah Jaya is strongly advised to prioritize "Service Excellence" training for front-line employees and ensure operational efficiency at the cashier counter..

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