Prediction using C4.5 Method and RFM Method for Selling Furniture

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*Abstract***:** *Based on sales transaction data in Borobudur Furniture, it can be seen that customer demand for furniture can be said to be large, therefore special methods are needed to estimate sales that are most in-demand by customers in the future, and also special methods used to provide customer loyalty ratings. The method used to predict sales is the C4.5 method, while the method used to provide customer ratings based on customer loyalty is the RFM method. Through the process of data mining with the C4.5 method, it was found that the five items most in demand by customers were wardrobe, office chairs, buffet tv, guest table, and sofa set. While using RapidMiner as a test, the precision results are 63.64%, 89.36% for recall and 60.81% for accuracy. While through the RFM analysis process that has been carried out, there are four categories of customers and the minimum RFM total point is 3 points while the maximum RFM total point is 12 points.*

Keywords **:** *C4.5, Customer Segmentation, RFM, Sales Prediction.*

I. INTRODUCTION

Sales is an activity that aims to seek, influence and give instructions to buyers to be able to adjust their needs to the products offered and enter into agreements regarding prices that are beneficial for both parties [1]. The industrial world is a business world full of competition between one company and another, therefore a prediction is needed in any case to help a company implement policies and strategies going forward. Prediction is a combination of art and science in predicting conditions in the future, by projecting past data into the future by using mathematical models and estimates that are subjective [2].

Prediction or forecasting the number of sales is an important factor that determines the smooth running of a business. The accuracy of the results of business forecasting will increase the chances of achieving investments that benefit the company [3]. Prediction is usually used to find information from a number of data from a company and usually the data used is large and large so data mining is needed.

Data mining is not a completely new field. In its application, data mining is actually part of the Knowledge Discovery in Database (KDD) process, not as a whole and independent technology[4]. Data Mining is a technique for processing and extracting large data into information which can form new data [5]. Data mining is a science field that systematically and logically studies a sequence of procedures to investigate an information collection to gain hidden knowledge. The Excavation may take the form of information finding patterns [6]. Data mining can be used to extract information from large data so that information can be used to predict selling furniture.

There are many methods that can be used in data mining to predict one of them is the C4.5 (Decision Tree) method. C4.5 algorithm is a decision tree method that converts very large facts into decision trees that represent rules, rules can be easily understood by natural language [7]. C4.5 algorithm is a very popular algorithm for classification in machine learning and data processing [8].

Borobudur Furniture is a firm for interior design and sales of furniture. Furniture for sale include: Guest Table, Bed, Wardrobe, Dining Table, Sofa Set and other types of furniture. Judging from the large number of consumer requests for furniture, it requires a prediction for the sale of furniture that is most requested by consumers.
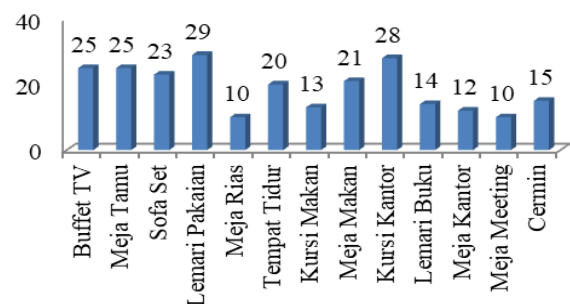
Fig. 1. 2018 Furniture Selling Data

According to figure 1. the company does not yet have a specific method in predicting and determining the most purchased products, using the C4.5 method can be predicted and determined the most purchased products more accurately, in this study only predicts the most purchased products whose transaction status is "SOLD". By using the Data mining implementation with the C4.5 algorithm method is expected to predict the most purchased furniture sales and can help the company, especially in the production of furniture production planning, besides that it can also inform the company about the most purchased products by consumers.

The company also does not have a specific method used to provide loyalty ratings to customers who make transactions for a certain period, so after making a prediction using the

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C4.5 method, customer segmentation analysis is first done using the RFM method to see the loyaliity of each customer, the aim is to facilitate the company in determining future business strategies and providing services adapted to the requirements of customer category obtained from the analysis using RFM.

II. STUDY LITERATURE AND PREVIOUS RESEARCH

A. KDD

Knowledge discovery in databases (KDD) is the method of determining helpful data information and patterns. According to [9] Knowledge Discovery Database (KDD) has several stages of the process as can be seen in figure 2.
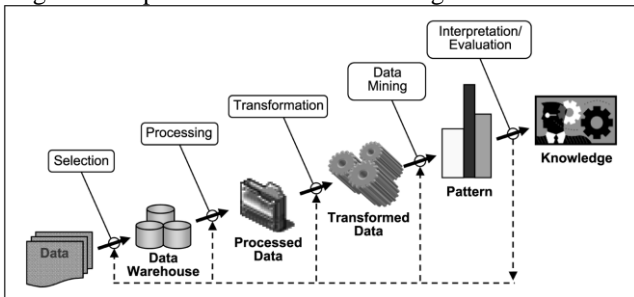

Fig. 2. Process Knowledge Discovery Database (KDD)[10]

B. C4.5

C4.5 algorithm is one of the algorithms used to form a decision tree based on training data. This algorithm is a very strong and famous classification and prediction method [11]. C4.5 algorithm. is a decision tree algorithm group. In the form of training samples, this algorithm has input. Training samples in the form of sample information will be used to construct a correctly tested tree. While samples are data fields that we will use as parameters in classifying data [12].

The steps used to make a decision tree with the C4.5 algorithm is. First, prepare training data. Training data is taken from previous data or that has occurred before and has been grouped in certain classes. Next, calculate the root of the tree. The root is taken from the chosen attribute, by calculating the gain value of each attribute used, the maximum gain value is used as the first root. The entropy value must be calculated before calculating the gain value of the attribute used. To calculate the entropy value using the formula:

$$Entropy(S) = \sum_{i=1}^{n} - pi * \log 2\, pi \qquad (1)$$

The next step is to calculate the gain value using the formula:

$$Gain(S, A) = Entropy(S) - \sum_{i=1}^{n} \frac{|si|}{s} * Entropy(Si) \qquad (2)$$

The next step repeat the steps until all records are fixed. The decision process partition tree will stop when:
a. All records in node N get the same class.
b. There are no attributes in the partitioned record again.
c. There are no records in the empty branch.

C. RFM

This model analysis was first introduced by Hughes and is currently widely used by industries including manufacturing, retailers, and the service industry [13]. This RFM seeks to determine customers segmentation based on three factors: Recency of the last purchase, Purchase Frequency and Purchase Monetary Value [14].

According to [15] RFM method consists of three dimensions:
a. Recency is measuring customer value by looking at customer behavior concerning the most recent purchases made.
b. Frequency is measuring customer value by looking at customer behavior regarding the transaction activities carried out by consumers in one period.
c. Monetary is measuring customer value by looking at customer behavior with regard to the total transactions made by customers in one period.

In the process of calculating the distance range of recency, frequency, and monetary, previously done first calculate the value of each of the three indicators (recency, frequency, and monetary). To get the recency, frequency, and monetary range, you can use a statistical calculation using the odd (n) lot of data quartile formula (3).

$$Qi = i\,\frac{(n+1)}{4} \qquad (3)$$

Information :
Qi = i Quartile i
n = Lots of data

D. Previous Research

From previous studies, researchers found several studies that discussed topics related to research researchers, including the use of the C4.5 method to predict various things and the use of RFM analysis as a segmentation method. first research [16] C4.5 algorithm with the decision tree method can provide predictive rule information to describe the processes associated with predicting motorcycle sales. C4.5 algorithm is considered as an algorithm which is very helpful in classifying data because the characteristics of classified data can be obtained, both in the form of decision tree structures and if-then rules, making it easier for users to extract information from the relevant data. In the selection of attributes also greatly affect the processing of C4.5 Algorithm because the decision is very dependent on the selected attribute. Second research [17] the purchase of wallpapers using the Data Mining method, in particular the C4.5 algorithm, will be very useful in the purchase of wallpapers. Third research [18] CRM systems using the RFM method can assist businesses to adapt the provision of the correct sort of service to their customers and also assist businesses to identify the list of services to be provided to their customers. Fourth Research [19] RFM-based customer segmentation generates 2 ideal clusters, specifically occasional customers and dormant customers. Based on the amount of book kinds bought, customer segmentation generates 3 ideal clusters, namely low, medium and high. With the outcomes of this research, Kompas Gramedia Value Card (KGVC) firms are anticipated to assist in determining the suitable approach to boost the number of book purchases.

III. METHOD

At this stage, the authors identify by collecting several references, what methods should be used in obtaining data, and analyzing data.

A. Location Research and Data Source

This research was conducted at the head office of Borobudur Furniture, Jl. Bongo 3 Blok I No. 1-2, Kelapa Gading,

North Jakarta, Indonesia. The data that will be used in data mining processing uses the C4.5 method, namely furniture sales transaction data based on the 2018 transaction database (January 2018 - December 2018). While the data used in processing customer segmentation uses the RFM method, namely customer transaction data from January 1, 2018, to April 29, 2019.

B. Data Collection

Data collection techniques used in this study are as follows:

1. Observation
The observation in this study was carried out by direct observation and research on Borobudur Furniture to obtain and collect the data needed.

2. Literature Study
Literature study conducted in this research is done by reading, quoting from books, literature, and journals that discuss theories relating to the methods used.

3. Interview
Doing questions and answers to leaders and employees of the company related to the problem being investigated by researchers.

C. Research Flow

The first stage carried out in this research is a review of the part that will be examined to observe and carry out deeper exploration and explore existing problems. The second stage is the determination of objectives, based on the issues that were then identified, which are the objectives to be accomplished.. Then in the third stage, data and information is collected, data and information can be obtained through observation, interviews, and literature study with the aim to find out information about the method use that to fix the issue being studied, and get a strong reference basis for researchers in applying a method that will be used. In the fourth stage, data mining is processed, at this stage, data mining is processed using the C4.5 method. The gathered information is processed in accordance with Knowledge Discovery in Database (KDD) phases.. Next in the fifth stage is RFM analysis, at this stage, analysis and weighting of each value are carried out by applying the RFM (Recency, Frequency, and Monetary) methods. For the sixth or final stage is the determination of conclusions from the research conducted.

IV. RESULT AND DISCUSSION

In Chapter IV, researchers will discuss the results of data mining processing with the C4.5 method and customer segmentation using the RFM method at Borobudur Furniture. The results of data mining processing and customer segmentation will be explained below.

A. C4.5

The first step in processing data mining using the C4.5 method is data collection. The data that will be used in data mining processing is the furniture sales transaction data based on Borobudur Furniture sales transaction database. Examples of transaction data can be seen in table 1.

Table- I: Sales Transaction Database

Transaction Date	Customers Name	Category	Goods	City of Customers	Price
01/01/2018	Superior Furniture	Office Furniture	Bookcase	Jakarta	Rp2.950.000
02/01/2018	Multi Jaya Furniture	Dinning Room	Dining table	Jakarta	Rp1.950.000
03/01/2018	Isnaeni Rizal	Living Room	Buffet TV	Jakarta	Rp1.530.000
07/01/2018	Indah Furniture	Dinning Room	Dining chair	Tangerang	Rp1.100.000
08/01/2018	Jaya Furniture	Bed Room	Dresser	Bekasi	Rp1.150.000

The next step is cleaning the data, from the sales transaction database that can be seen in Table I, cleaning the data which includes removing data duplication, checking data inconsistencies, and correcting data errors.

The next stage is the selection of attributes that will be used for data selection for data mining processing, each attribute selected has its contents, attributes and values used in data selection can be seen in Table II.

Table- II: Data Selection Attribute

Attributes	Values
Category	Accessories, Bed Room, Living Room, Office Furniture, Dinning Room
Goods	Buffet TV, Mirror, Office Chair, Dining Chair, Bookcase, Wardrobe, Office Desk, Dining Table, Meeting Table, Dressing Tables, Guest Tables, Sofa Set, Bed
City of Customers	Jakarta, Bogor, Depok, Tangerang, Bekasi

The next step is data transformation. Based on 2018 sales transaction data at Borobudur Furniture, there are two transaction statuses, namely transaction data with the final status of goods sold and transaction data whose final status is not sold. The percentage comparison of status sold and not sold can be seen in Figure 3.
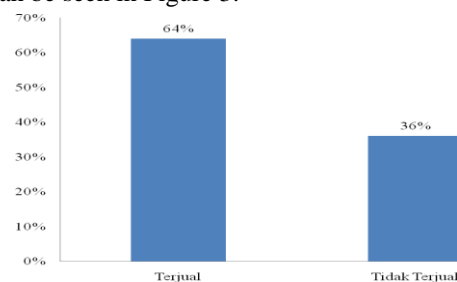
Fig. 3. Percentage of Transaction Status

The next stage carried out in the data mining process is the search for entropy values of each attribute content, and also the search for information gain values from each category, examples of the results of calculations can be seen in Table III.

Table- III: Calculation of Entropy and Information Gain

	Number of cases (S)	Sold (S1)	Not sold (S2)	Entropy	Gain
Total		245	156	89	0,945360300	
						0,002713287
Category	Living Room	73	47	26	0,939453207	
	Bed Room	59	40	19	0,906579548	
	Dinning Room	34	20	14	0,977417818	
	Office Furniture	64	40	24	0,954434003	
	Accessories	15	9	6	0,970950594	
						0,010973898
Goods	Buffet TV	25	15	10	0,970950594	
	Mirror	15	9	6	0,970950594	
	Office chair	28	18	10	0,940285959	
	Dining chair	13	7	6	0,995727452	
	Bookcase	14	8	6	0,985228136	
	Wardrobe	29	21	8	0,849751137	
	Office desk	12	7	5	0,979868757	
	Dining table	21	13	8	0,958711883	
	Meeting table	10	7	3	0,881290899	
	Dresser	10	5	5	1,000000000	
	Guest table	25	17	8	0,904381458	
	Sofa Set	23	15	8	0,932111568	
	Bed	20	14	6	0,881290899	
						0,021207193
City of Customers	Bekasi	39	26	13	0,918295834	
	Bogor	53	28	25	0,997687576	
	Depok	30	16	14	0,996791632	
	Jakarta	82	55	27	0,914177044	
	Tangerang	41	31	10	0,801469893	

The next stage is an interpretation, in this study using the RapidMiner application as an interpretation tool. The result of the decision tree based on testing using the RapidMiner application can be seen in Figure 4.
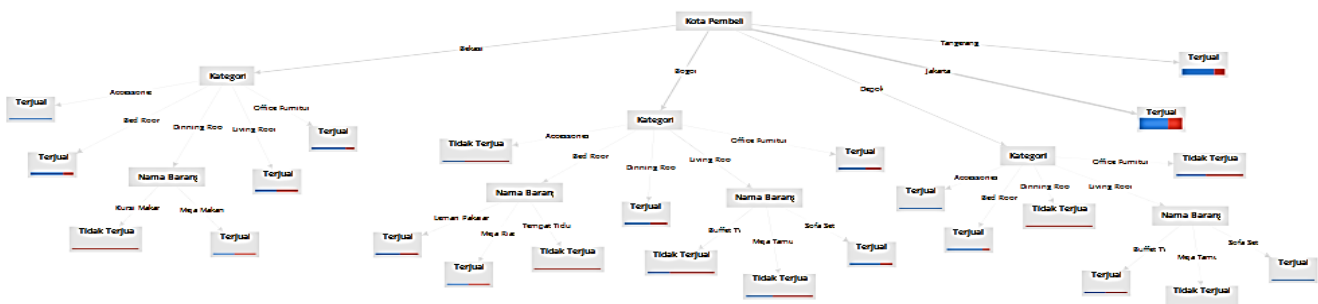

Fig. 4. Decision Tree Interpretation

The results of the interpretation of the C4.5 method in the RapidMiner application can be seen in Table IV.

Table- IV: Results of Interpretation on RapidMiner

Accuracy	Precision	Recall
60,81%	63,64%	89,36%

In Table IV It Can Be Explained That The Accuracy Of The Performance Of The C.45 Algorithm In Predicting Furniture Sales Is 60.81%, For Precision Is 63.64, And For The Recall Is 89.36.

B. RFM

Transaction Data has been defined and up to date In the initial process of analyzing customer segmentation using this RFM method, data regarding customer transactions must be defined in advance and. This transaction data will later be used as a reference in awarding points. Transaction data obtained from customer transactions. Examples of data to be used can be seen in Table V.

Table- V: Customer Transaction Data

Transaction Date	Customers Name	Category	Goods	City of Customers	Price
01/01/2018	Superior Furniture	Office Furniture	Bookcase	Jakarta	Rp2.950.000
02/01/2018	Multi Jaya Furniture	Dinning Room	Dining table	Jakarta	Rp1.950.000
03/01/2018	Isnaeni Rizal	Living Room	Buffet TV	Jakarta	Rp1.530.000
07/01/2018	Indah Furniture	Dinning Room	Dining chair	Tangerang	Rp1.100.000
08/01/2018	Jaya Furniture	Bed Room	Dresser	Bekasi	Rp1.150.000

The next step is to calculate each value of the three indicators (recency, frequency, and monetary). Examples results of the calculation can be seen in Table VI.

Table- VI: Recency, Frequency, and Monetary Values

Customers Name	Recency	Frequency	Monetary
Jaya Sukses Furniture	0	5	Rp8.100.000
Jepara Indah	6	7	Rp11.680.000
Oey Cui Kiang	9	2	Rp3.480.000
Cahaya Baru Furniture	14	3	Rp3.930.000
Grand Sinar Sari	14	6	Rp24.450.000

The next step is to calculate the distance range of recency, frequency, and monetary. To get the recency range, you can use statistical calculations with the odd (n) lot of data quartile formula, see equation (3). The number of customer data is 47 data. Calculation as follows:

$Q1 = 1\frac{(47+1)}{4} = 12$ The 12th data is data with 44 days recency.

$Q2 = 2\frac{(47+1)}{4} = 24$ The 24th data is data with 104 days recency.

$Q3 = 3\frac{(47+1)}{4} = 36$ The 36th data is data with 244 days recency.

Based on the above calculation, the recency distance range can be determined ie:

1. Recency $\leq$ 44 days then including customers with a 4 point scale.
2. 45 days $\leq$ Recency $\leq$ 104 days then including customers with a point scale of 3.
3. 105 days $\leq$ Recency $\leq$ 244 days then includes customers with a point scale of 2.
4. Recency $\geq$ 245 days then including customers with a scale of point 1

Similar to recency, to get the frequency range you can use statistical calculations with quartile formulas for many (n) odd data see equation (3). Calculation as follows:

$Q1 = 1\frac{(47+1)}{4} = 12$ The 12th data is data with a frequency of 2 times.

$Q2 = 2\frac{(47+1)}{4} = 24$ The 24th data is data with a frequency of 3 times.

$Q3 = 3\frac{(47+1)}{4} = 36$ The 36th data is data with a frequency of 6 times.

Based on the above calculation, frequency range can be determined, namely:

1. Frequency $\leq$ 2 times, including customers with a point scale of 1.
2. Frequency = 3 times, including customers with point scale 2.
3. Frequency $\leq$ 6 times, including customers with a point scale of 3.
4. Frequency> 6 times, including customers with a point scale of 4.

As with recency and frequency, calculating monetary distance ranges using quartile formulas for odd (n) data see equation (3). Calculation as follows:

$Q1 = 1\frac{(47+1)}{4} = 12$ The 12th data is monetary data of Rp. 4,150,000.

$Q2 = 2\frac{(47+1)}{4} = 24$ the 24th data is monetary data of Rp 6,950,000.

$Q3 = 3\frac{(47+1)}{4} = 36$ the 36th data is monetary data of IDR 14,810,000.

Based on the above calculation, you can determine the range of monetary distances, namely:

1. Monetary $\leq$ Rp. 4,150,000, including customers with a point scale of 1.
2. Rp. 4,150,001 <Monetary $\leq$ Rp. 6,950,000, including customers with a point scale of 2.
3. Rp. 6,950,001 <Monetary $\leq$ Rp. 14,810,000, including customers with a point scale of 3.
4. Monetary> Rp. 14,810,000, including customers with a point scale of 4.

From the previous RFM distance range calculation, RFM point scale can be made. The point scale is obtained between 1-4 points because there are four groups of customer categories. The following RFM point scale can be seen in table VII.

Table- VII: RFM Point Scale

Attributes	Point Scale			
	4 Point	3 Point	2 Point	1 Point
Recency (R)	≤ 44 Days	45-104 Days	105-244 Days	≥ 245 Days
Frequency (F)	> 6 Times	≤ 6 Times	3 Times	≤ 2 Times
Monetary (M)	M > Rp 14.810.000	Rp 6.950.001 < M ≤ Rp 14.810.000	Rp 4.150.001 < M ≤ Rp 6.950.000	M ≤ Rp 4.150.000

Table VII shows that the complete points achieved by adding the attributes (R + F + M). If the minimum point of each attribute is 1, then the minimum total point (R + F + M) of the customer is 3. Whereas if the maximum point of each attribute is 4, then the maximum total point (R + F + M) of the customer is 12.

The next stage is the awarding of RFM points based on sample transaction data which can be seen in table V. The awarding of RFM points refers to table VII. Examples of giving RFM points can be seen in table VIII.

Table- VIII: RFM Points

Customers Name	RFM						Total Point (R+F+M)
	R	Point	F	Point	M	Point	
Abadi furniture	102	3	7	4	Rp12.900.000	3	10
Afandi Drajat	350	1	2	1	Rp5.000.000	2	4
Agus Sutrisno	437	1	1	1	Rp2.950.000	1	3
Agustinus Wijaya	42	4	1	1	Rp1.450.000	1	6
Aldi Setyabudi	421	1	1	1	Rp1.150.000	1	3
Aneka Jaya Furniture	245	1	2	1	Rp4.150.000	1	3
Atria Furniture	34	4	5	3	Rp9.680.000	3	10
Bahagia Furniture	178	2	6	3	Rp18.930.000	4	9

V. CONCLUSION

From the results of data mining processing using the C4.5 method and customer segmentation using the RFM method, Several conclusions can be taken, including through the data mining method carried out using the C.45 algorithm with RapidMiner implementation known as new knowledge in the form of C.45 algorithm accuracy of 60.81%, 63.64% accuracy and 89.36% recall.. Found rules that can be used as a basis for companies to make sales predictions, to achieve profit targets so that companies can anticipate by taking the right business strategy. While through the RFM analysis process that has been carried out, there are four categories of customers and the minimum RFM total point is 3 points while the maximum RFM total point is 12 points.

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