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Data Mining Systems to Determine Sales Trends and Quantity Forecast Using Association Rule and CRISP-DM Method

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Abstract:

Customer is the most important part of the business, the data taken is a record of the purchase transactions of products purchased in each transaction. With the existence of data mining expected hidden and unknown pattern can be utilized in customer purchasing pattern. Then apriori algorithm as the basis of which there are methods of association rules and CRISP-DM in this system can determine thats the most products of interest by customers by applying data mining system on each transaction data. Result of data mining processing to determine sales trend towards a sales product where with this sales trend management team can analyze by disclosing which product sales follow steep growth path and which stall or decrease. An example of data mining to determine the sales trend pattern based on a combination of 2 products. Where it has been determined is Threshold Support = 0.1 and Threshold Support x Confidence = 0.05 and for the quantity forecast of 23 products into the sample and who managed to enter into quantity forecast only 13 products. Where the successful product is determined quantity forecast only that has a support value above the threshold support value that has been determined by the authors in this paper. Result of the quantity forecast of the input specified such as Threshold Support: 0.2, Threshold SupportxConfidence: 0.1 and Percent Forcast: 0.15.

Keywords — **Data mining, sales trend, quantity forecast, support, confidence, apriori algorithm, CRIPS-DM.**

I. INTRODUCTION

Data is something that has not been meaning, data that has been processed into an information, and that information that can be used. Knowledge in digging data is necessary in generating information so that it becomes something good that can be used for various purposes.

Data mining describes the discovery of knowledge in the database. The use of mathematical techniques, data analysis, artificial intelligence, and machine learning to produce related information from large databases. Data mining deals with the discovery of something hidden and certain data patterns that are not previously known.

In the management of data mining, the data set becomes a very important, coupled with the method of data mining will produce knowledge. This knowledge is in the form of patterns, formulas, rules, models emerging from the data. So it can be said that good knowledge will produce good information as wellunderline.

At this time the research to determine the pattern of sales trend and quantity forecast done at PT. Pinus Merah Abadi which is a distributor of vegetable products spread across the dots all over Indonesia, turnover is an important part of a distributor company because a good turnover will be good for human resources as it will open a new point, so it will certainly require a new workforce and promotion for the able and responsible.

Customer is the most important part of the sale, therefore need to be analyzed up to the level of customer, the data taken is a record of purchase transactions, The data must be considered include the product mix purchased in each transaction and the quantity or quantity of products purchased in each transaction. With the existence of data mining expected hidden and previously unknown pattern can be utilized in customer purchasing pattern. Then this research look for pattern of taking customer goods based on transaction data to determine sales trend and quantity forecasting in PT. Pinus Merah Abadi based on the value of support and confidence.

II. RELATED WORK

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A. *Data Mining*

From a business perspective, data mining is to achieve deeper analysis on a large number of enterprise data according to the established enterprise business goals, the aim is to discover the unknown, hidden potential rules and convert them into a corresponding model, thus supporting business decision support activities.

Data mining (Han & Kamber in Rodiyansyah, 2015) is the process of extracting information from a data set using algorithms and techniques that science, engineering and databases. Data mining is used for extraction. With the data mining, it will get a gem of knowledge (knowledge) in a collection of data that many.

Data mining or machine learning (Lu et al., 2017) is a semi-empirical strategy that uses known data about properties and descriptors (including computational and experimental parameters) of some materials to find semiempirical rules, and uses this rule to predict and evaluate unknown properties of material.

The following are the parts of the data mining that will be described in this research:

1) ***Data Mining Process***

Data mining process is generally composed by several major phases such as mining objects determination, data preparation, data mining, structural analysis expression and mining application. Data mining can be described as arepetition of these stages, particularly shown in figure 1.

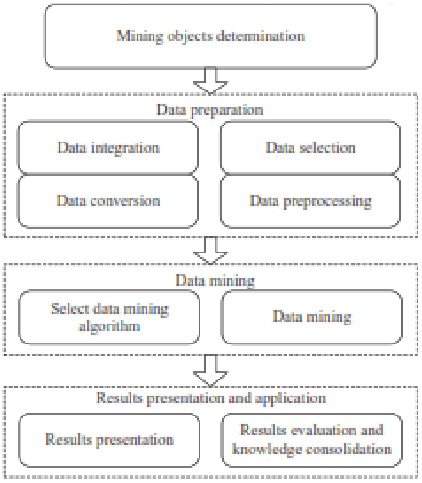

Mining objects determination
Data preparation
Data integration
Data selection
Data conversion
Data preprocessing
Data mining
Select data mining algorithm
Data mining
Results presentation and application
Results presentation
Results evaluation and knowledge consolidation

Fig. 1 Data Mining Process

Data mining, at this stage the actual mining operations, namely by the use of machine learning, statistical analysis and other methods to find useful patterns or knowledge from the database, including data mining method selection, data mining algorithm selection, and data mining.

Results analysis presentation and mining applications, including results expression, to intuitively express the mining results as far as possible, let it easy for users to understand and use; results evaluation, to select and evaluate th e useful part of mining results, and then find the acceptable results; knowledge consolidation, to gather the extracted information to the execution system, understand the role of such information or evidence it.

2) ***System Structure of Data Mining***

Although data mining regarded as a basic step of data base knowledge discovery process is more scientific, but in the industry, the media and the database research field, directly as a data base knowledge discovery is more prevalent. Therefore, data mining has a broader concept: it is a process to extract interesting knowledge from a lot of data stored in databases, data warehouses or other information warehouses. Based on this view, a typical data mining system may consist of the following main components, shown in figure 2.

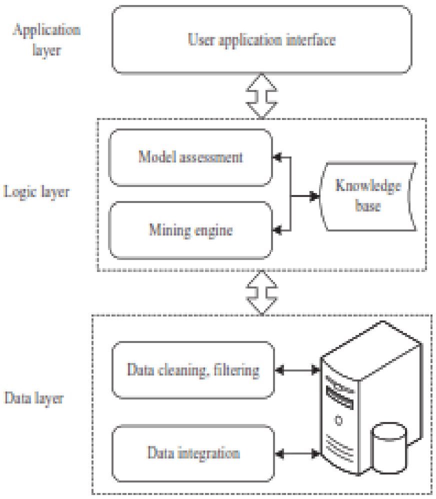


Fig. 2 System Structure of Data Mining

B. Definision of Association Rule

The most actively researched area among data mining techniques involves discovering the association rule that represents the association among data.

Association rules regarding the study of "what's with what". The rules or the prevailing market analysis, the rules want to make the information in the form of an "if-then" or "if-then" relationship. This rule is calculated from probabilistic data.

Association rules will find a particular pattern that associates one data with another. Frequent itemset is a set of items that often appear simultaneously to search the association rules of the data set, the first stage to do is to find frequent itemset first. Once the frequent itemset pattern is found, then look for associative rules or link rules that meet the specified requirements

C. Apriori Alghoritm

A priori algorithm or often called association rule mining is a data mining technique for finding association rules between a combination of items. (Rodiyansyah, 2015) Let i = {i1, i2, i3, .. in} be a set of items and D is the set of transaction databases that each T transition is a set of items contained in a transaction T. Each transaction is associated with an identifier called TID. Rules that meet the minimum support (min_sup) and minimum confidence (min_conf) are called strong candidate rules. Under the convention, the value of support and confidence value is a value between 0% to 100% proportional to 0 to 1,0. In the Apriori algorithm determine the candidate that may appear by paying attention to the minimum support and minimum confidence. Support is the value of the visitor or the percentage of the combination of an item in the database. The support formula is as follows:

$$Support\ A = \frac{\text{Number of Transactions Contains A}}{\text{Total Transaction}}\ X\ 100\%$$

While confidence is the value of certainty is the strength of the relationship between items in an Apriori. Confidence can be searched after the frequency pattern of the appearance of an item is found. The formula for calculating confidence is as follows: Example for example found rule A→ B then:

$$Confidence\ \text{P(B|A)} = \frac{\text{Number of Transactions Contains A and B}}{Transaction\ Contains\ A}\ X\ 100\%$$

Apriori algorithm has principles, among others:

a. Collect single items then search for the biggest item.
b. Get the candidate pairs then count the large pairs of each item.
c. Find candidate triplets from each item and so on.
d. Every subset of a frequent itemset should be frequent.

D. CRISP-DM

CRISP-DM (Cross Industry Standard Process for Data Mining) is a consortium of companies established by the European Commission in 1996 and has been established as a standard process in data mining that can be applied in various industry sectors.

The following are the six stages of the life cycle of data mining development:

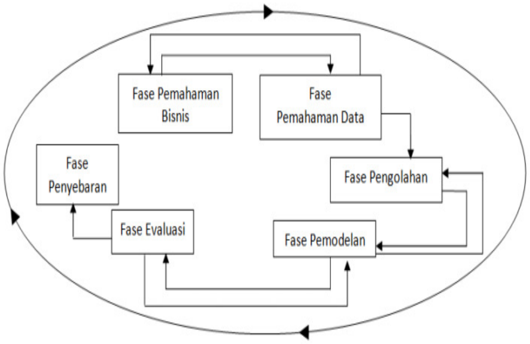


Fig. 3 CRISP-DM Data Mining Process

III. METHODOLOGY

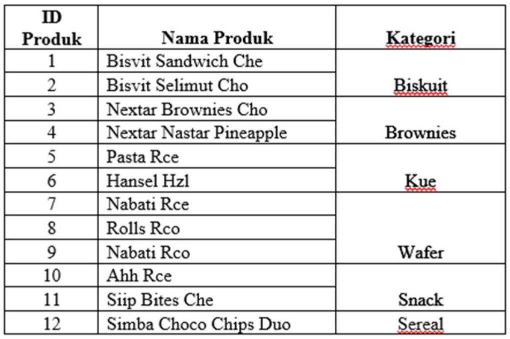
This research discusses the data mining system to determine the pattern of sales trend and quantity forecast using the method of association rules with a priori algorithm as its base. Here is the explanation abou the method.

A. Performance of association rule apriori algorithms

All Manual Calculation of Apriori Algorithms:

1. Create master table of goods

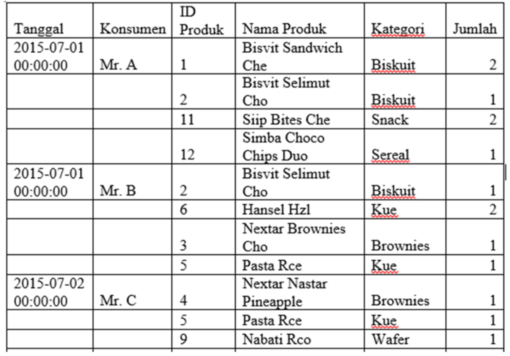
TABLE I
Master Table of Goods



ID Produk	Nama Produk	Kategori
1	Bisvit Sandwich Che	Biskuit
2	Bisvit Selimut Cho	
3	Nextar Brownies Cho	Brownies
4	Nextar Nastar Pineapple	
5	Pasta Rce	Kue
6	Hansel Hzl	
7	Nabati Rce	Wafer
8	Rolls Rco	
9	Nabati Rco	
10	Ahh Rce	Snack
11	Siip Bites Che	
12	Simba Choco Chips Duo	Sereal

2. Create table transaction of goods

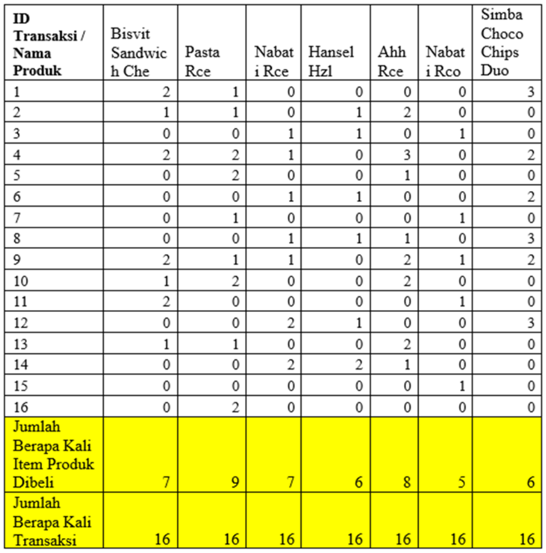
TABLE II
Table Transaction of goods



Tanggal	Konsumen	ID Produk	Nama Produk	Kategori	Jumlah
2015-07-01 00:00:00	Mr. A	1	Bisvit Sandwich Che	Biskuit	2
		2	Bisvit Selimut Cho	Biskuit	1
		11	Siip Bites Che	Snack	2
		12	Simba Choco Chips Duo	Sereal	1
2015-07-01 00:00:00	Mr. B	2	Bisvit Selimut Cho	Biskuit	1
		6	Hansel Hzl	Kue	2
		3	Nextar Brownies Cho	Brownies	1
		5	Pasta Rce	Kue	1
2015-07-02 00:00:00	Mr. C	4	Nextar Nastar Pineapple	Brownies	1
		5	Pasta Rce	Kue	1
		9	Nabati Rco	Wafer	1

3. Create a Transaction Data Matrix

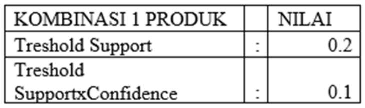
TABLE III
Table Transaction Data Matrix



ID Transaksi / Nama Produk	Bisvit Sandwich Che	Pasta Rce	Nabati Rce	Hansel Hzl	Ahh Rce	Nabati Rco	Simba Choco Chips Duo
1	2	1	0	0	0	0	3
2	1	1	0	1	2	0	0
3	0	0	1	1	0	1	0
4	2	2	1	0	3	0	2
5	0	2	0	0	1	0	0
6	0	0	1	1	0	0	2
7	0	1	0	0	0	1	0
8	0	0	1	1	1	0	3
9	2	1	1	0	2	1	2
10	1	2	0	0	2	0	0
11	2	0	0	0	0	1	0
12	0	0	2	1	0	0	3
13	1	1	0	0	2	0	0
14	0	0	2	2	1	0	0
15	0	0	0	0	0	1	0
16	0	2	0	0	0	0	0
Jumlah Berapa Kali Item Produk Dibeli	7	9	7	6	8	5	6
Jumlah Berapa Kali Transaksi	16	16	16	16	16	16	16

4. Create a rule based on Threshold Support and Threshold SupportxConfidence

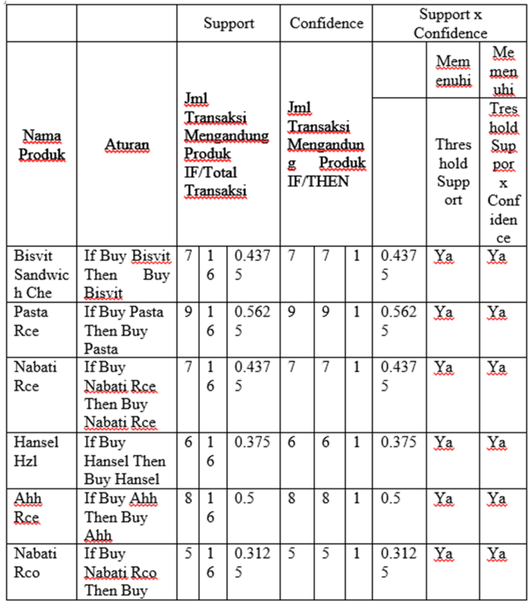
TABLE IV
Nilai Treshold



KOMBINASI 1 PRODUK		NILAI
Treshold Support	:	0.2
Treshold SupportxConfidence	:	0.1

5. Result the value of support and confidence for sales trend and quantity forecast.

TABLE V
Tabel Transaction Support x Confidence



		Support			Confidence			Support x Confidence		
Nama Produk	Aturan	Jml Transaksi Mengandung Produk IF/Total Transaksi			Jml Transaksi Mengandung Produk IF/THEN				Memenuhi	Memenuhi
									Threshold Support	Treshold Support x Confidence
Bisvit Sandwich Che	If Buy Bisvit Then Buy Bisvit	7	16	0.4375	7	7	1	0.4375	Ya	Ya
Pasta Rce	If Buy Pasta Then Buy Pasta	9	16	0.5625	9	9	1	0.5625	Ya	Ya
Nabati Rce	If Buy Nabati Rce Then Buy Nabati Rce	7	16	0.4375	7	7	1	0.4375	Ya	Ya
Hansel Hzl	If Buy Hansel Then Buy Hansel	6	16	0.375	6	6	1	0.375	Ya	Ya
Ahh Rce	If Buy Ahh Then Buy Ahh	8	16	0.5	8	8	1	0.5	Ya	Ya
Nabati Rco	If Buy Nabati Rco Then Buy	5	16	0.3125	5	5	1	0.3125	Ya	Ya

B. *Stratified Random Sampling*

Sampling in this research with probability sampling technique that is proportionate stratified random sampling by using slovin formula. Probability sampling is a sampling technique that provides equal opportunity for each element (member) of the population to be selected as a sample member.

The amount of sample in this study is determined by the Slovin formula as follows:

$$n = \frac{N}{1+Ne^2}$$

Definition:

n = Number of samples

N = Population

e = error level (note: commonly used 1% or 0.01, 5% or 0.05 and 10% or 0.1).

The population in this research is 54 product and precision is determined or 5% significance level, so the sample size in this research are:

$n = \frac{30}{1+30 \, x \, 0.1^2} = 23{,}0169$ dibulatkan menjadi 23.

So, the total number of products that will become sales trend and quantity forecast in this research is 23 product.

IV. RESULT AND DISCUSSION

1. *SALES TREND*

Sales trends in this study become a methodology for understanding sales results that help in understanding market trends over a period of time. Sales results are indicators of sales patterns followed by the customer over a certain period of time. Timed can be short, average or long. Sales trends can be analyzed by compiling sales and employment over a period of time to the financial statements.

The following is a data mining experiment in determining sales trend towards a sales product where with this sales trend management team can analyze by disclosing which product sales follow steep growth path and which stall or decrease. An example of data mining to determine the sales trend pattern based on a combination of 2 products.

Where it has been determined:

Threshold Support = 0.1

Threshold Support x Confidence = 0.05

TABEL VI
Nilai Sales Trend kombinasi 2 produk

Aturan	Support	Confidence	Supportx Confidence	Threshold Support	Threshold Confidence
If Buy RICHEESE AHH TRIPLE CHEESE 5 And Buy 5g Then Buy RICHEESE AHH TRIPLE CHEESE 16g	0.417061611374	0.862745098039	0.359817860794	Ya	Ya
If Buy 5g And Buy RICHEESE AHH TRIPLE CHEESE 16g Then Buy RICHEESE AHH TRIPLE CHEESE 5	0.417061611374	0.785714285714	0.32769126608	Ya	Ya
If Buy RICHEESE WAFER KEJU 24G And Buy RICHEESE AHH TRIPLE CHEESE 5 Then Buy 5g	0.123222748815	0.232142857143	0.0286052809749	Ya	Tdk
If Buy RICHEESE AHH TRIPLE CHEESE 5 And Buy 5g Then Buy NABATI PINK LAVA 50g	0.085308056872	0.6	0.0511848341232	Tdk	Ya
If Buy 5g And Buy NABATI PINK LAVA 50g Then Buy RICHEESE AHH TRIPLE CHEESE 5	0.085308056872	0.160714285714	0.0137102234259	Tdk	Tdk
If Buy NABATI PINK LAVA 50g And Buy RICHEESE AHH TRIPLE CHEESE 5 Then Buy 5g	0.085308056872	0.160714285714	0.0137102234259	Tdk	Tdk
If Buy RICHEESE AHH TRIPLE CHEESE 5 And Buy 5g And Buy SIIP KEJU 6 Then Buy 5g	0.530805687204	1	0.530805687204	Ya	Ya

Based on the above table data that provides information about the values and descriptions of threshold support and threshold confidence it can be concluded that in determining sales trend patterns are as follows.

The 2 product combination rule is based on the largest SupportxConfidence value:

Most likely if you buy RICHOCO WAFER 50K CHOCOLATE then buy RICHEESE WAFER CHEESE 50g with a value of 0.801609785803. If any product RICHEESE WAFER KEJU 50g with a certain brand is less salable, then it can be placed next to RICHOCO WAFER COKLAT 50g product with a certain brand that sells, it will probably sell well.

2. *Quantity Forecast*

Quantity forecasting of product sales that will be the process of estimating future sales. Accurate sales estimates allow companies to make sound business decisions and predict short-term and long-term performance. Companies can base their forecasts on recent sales data, industry-wide comparisons, and economic trends.

Quantity forecasting of sales of these products gives insight into how companies should manage in predicting the sales revenue that can be achieved, efficiently allocate resources, planing future sales product growth.

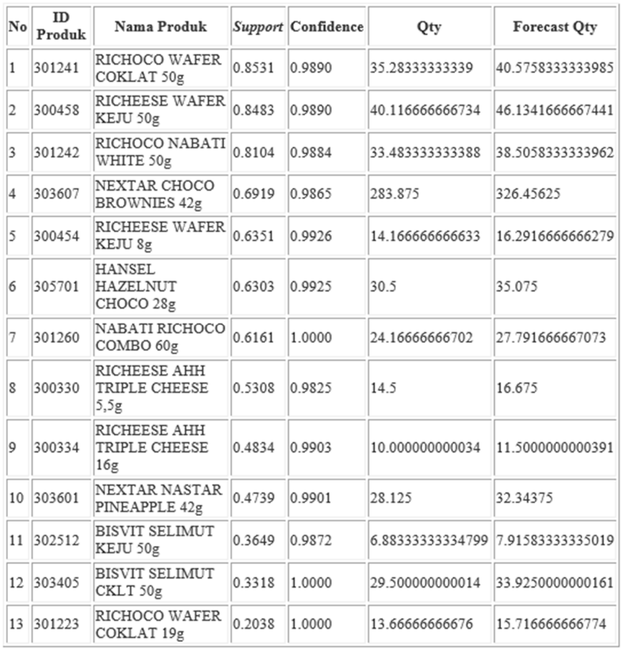
The following is the result of data mining processing to determine the quantity forecast of 23 products into the sample and who managed to enter into quantity forecast only 13 products. Where the successful product is determined quantity forecast only that has a support value above the threshold support value that has been determined by the authors in this paper.

The table below is the result of the quantity forecast of the input specified by the author as follows:

Threshold Support: 0.2
Threshold SupportxConfidence: 0.1
Percent Forcast: 0.15

Then the value of quantity forecast generated is 15% of the amount of quantity that has been predetermined by the management team before the calculation process begins.

TABEL VII
Value of Quantity Forecast



No	ID Produk	Nama Produk	*Support*	Confidence	Qty	Forecast Qty
1	301241	RICHOCO WAFER COKLAT 50g	0.8531	0.9890	35.28333333339	40.5758333333985
2	300458	RICHEESE WAFER KEJU 50g	0.8483	0.9890	40.116666666734	46.1341666667441
3	301242	RICHOCO NABATI WHITE 50g	0.8104	0.9884	33.483333333388	38.5058333333962
4	303607	NEXTAR CHOCO BROWNIES 42g	0.6919	0.9865	283.875	326.45625
5	300454	RICHEESE WAFER KEJU 8g	0.6351	0.9926	14.166666666633	16.2916666666279
6	305701	HANSEL HAZELNUT CHOCO 28g	0.6303	0.9925	30.5	35.075
7	301260	NABATI RICHOCO COMBO 60g	0.6161	1.0000	24.16666666702	27.791666667073
8	300330	RICHEESE AHH TRIPLE CHEESE 5,5g	0.5308	0.9825	14.5	16.675
9	300334	RICHEESE AHH TRIPLE CHEESE 16g	0.4834	0.9903	10.000000000034	11.5000000000391
10	303601	NEXTAR NASTAR PINEAPPLE 42g	0.4739	0.9901	28.125	32.34375
11	302512	BISVIT SELIMUT KEJU 50g	0.3649	0.9872	6.88333333334799	7.91583333335019
12	303405	BISVIT SELIMUT CKLT 50g	0.3318	1.0000	29.500000000014	33.9250000000161
13	301223	RICHOCO WAFER COKLAT 19g	0.2038	1.0000	13.66666666676	15.716666666774

Based on the data above table then to clarify the value of quantity forecast the authors will describe it in the form of chart diagram, as follows:

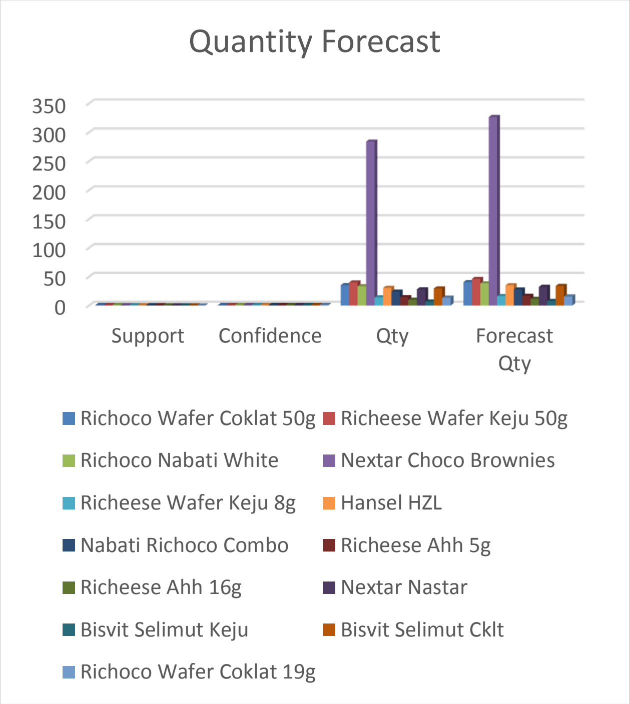


Fig. 4 Grafik Quanity Forecast

Data mining system has been able to determine the Quantity Forecast for each product to be sampled in this study with the evidence of tables and graphs generated by the system.

V. CONCLUSIONS

In this paper conducted by this author has been able to produce the pattern of selling the most products of interest by customers by applying data mining system on each transaction data. By using a priori Algorithm as the basis of which there are methods of association rules and CRISP-DM in this system can determine the value of support and confidence of the implementation of data mining based on the rules of the combination of products as input value. Because of the value of support and confidence obtained from association rules in data mining has been able to assist the management team in determining sales trend and quantity forecasting based on transaction data from each product sold to customers.

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