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The Use of Association Rule Mining in Determining Price, Promotion, Stock, and Product Arrangement in Store

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Abstract:

In the first quarter of 2017, the retail market in Indonesia increased 2.5% while in 2018 the growth was only around 1% -1.5%. The cause of this slow growth was the shift of the patterns of society consumption and it was still continuing in the early 2018. Besides that, it was also because of the decrease in productivity in the lower-class society. As a retail store, Anterah shop was also dealing with the same problem so that the analysis of the most sold product and how to figure out the correlation between the product bought by consumers are needed to anticipate a decline in sales. Associative correlation between these products will be used as the basic of the product arrangement, so that the frequency of products which are bought most frequently by consumers at the same time can be arranged nearby to make the consumers get the product quickly. Market basket analysis to figure out the correlation between the product which are sold at the same time, Association Rule Mining is issued, it will produce the product which will be bought at the same time as the consideration of product arrangement in the store of Anterah retail store. Meanwhile, the most sold product which will be mined by using Frequent Pattern Growth method so that the rating list of the most sold products will be obtained. This analysis is used as the background in considering product promotion. Test results on the sales sample data is shown as follows: minimum support = 0.0025, minimum confidence = 0.610, LaPlace = 0.9985, Gain = -0.006, p-s = 0.003, Lift = 103.82, Convicting 2.5285 with processing time 41.456 seconds.

Keywords: Market basket analysis, data mining, retail

1. Introduction

Anterah retail store is a grocery store and retailer which sells food, drinks and other products with competitive prices. The competitive price becomes the consideration of the society to shop. The price which are relatively inexpensive, affordable and do not only apply in a certain period of time will make the consumers interested to buy. However, a significant turnover decrease to the company has happened in the last three years.

Sales Turnover	2015	2016	2017
Jan – Apr	6.023.048.234	5.854.234.658	5.502.244.234
Mei – Agt	6.234.645.459.	5.986.456.245	5.678.345.734
Sep – Des	6.645.249.358	6.323.423.687	5.834.785.752

Figure 1: Intermediate Retail Data Turnover

A better strategy is needed to increase turnover through promotion and pricing. In the research [1] the methodology which is used is FP-Growth to determining the value of frequent itemset using FP-Tree tree structure and Association Rule algorithm is used to decide the value of support and confidence on the transaction data with the results that we can figure out the correlations between a product and another product which is frequently bought by consumers.

In the research [2] base on the algorithm test result of Data Mining Market Basket Analysis, it can be discovered that the mining of presence habit pattern (check-lock) of employees in a company. As a result, the possibility of cheating on presence, in and out, can be detected.

In the research [3] that apriori algorithm & frequent pattern growth (FP-Growth) can be used to find out some association rules from book sales transaction data in PT. Gramedia Printing, so that the result of analysis can be used as consideration in determining the more effective sales and marketing strategy.

Product arrangement at Anterah store at the moment is based on product group which has the same type and no analysis about the correlation between the products bought by consumers to arrange those products in the store. Product placement that has associative correlation to declare that the product at the same time is bought by consumers become important to be done. With the product at the right product arrangement, which is by arranging the layout of the product which are bought at the same time by consumers nearby, they can choose and take the products without looking for them in the different location (it takes more time for the consumers).

Market basket analysis apparently can be used to produce rule of arranging product in display window. The product which have associative correlation can be placed in the same display window, nearby one another it is hoped that consumers can find the product more quickly and reduce the time for shopping.

2. Research Methodology

2.1. Data Collection

MBA analysis using Frequent Pattern Growth algorithm and Association Rule Mining needs data source which is obtained from sales sample set uses Anterah's product sales data with 9999 sample data. The data were taken from sales transaction during five months to get the idea in that period of time as training data representation. The analysis will be conducted by taking data sample each month during five months so that frequent item, Frequent Pattern Growth & Association Rule with itemset (minimum of two item combinations & three item combinations) are obtained.

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Number of examples ≥ 100
At most 101 attributes:
Generated by: FP-Growth.example set ← Set Role.example set output
← Numerical to Binominal.example set output ← Replace Missing
Values.example set output ← Rename by Replacing.example set
output
Data: SimpleExampleSet: 2269 examples, 3390 regular attributes,
special attributes = { id = #: INVOICE (polynomial/single_value)
/Values=[899475502026, A11704010001, A11704010002,
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A11704010091, A11704010092, A11704010093, A11704010094,
A11704010095, A11704010096, A11704010097, A11704010098,
A11704010099, ... (2169 values) ...] }
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Figure 2: Anterah Retail Store Sample Data

RapidMiner is one of tools from the top ten data-mining analysis software. Knowledge Discovery in Database (KKD) is the whole field of new research about knowledge discovery from big data and unstructured. The term KKD is often used in datamining context which depicts a technique to extract knowledge from the data. Because of the big data quantity, this technique must be able to work efficiently. Extraction is commonly obtained from database by choosing the relevant data are needed for analysis phase to become a table as sample collection. Rapidminer can do extraction & drafting model at once. It is to run data analysis algorithm.

2.2. Market Basket Analysis

In the Market Basket Analysis, purchase pattern from consumers by discovering relationship pattern between different items which is done by consumers. It is expected that beside consumers purchase pattern which is usually done, it can be found out new patterns either as the number of goods purchase transaction is increasing.

Marker Basket Analysis is association correlation in data mining to get attribute value that appears in a period of time. In this process, consumers purchase patterns will be analyzed by finding out association correlation between different item that are put into shopping basket. The discovery of the future shopping items can be used by retail companies to set marketing strategy based on which items that are purchased at the same time by the consumers.

Parts in the sales attribute as reference in determining association correlation by using market basket analysis are purchased date attribute, invoice, product bought by consumers, number of purchases, unit & price. Number of data samples for market basket analysis are 9999 data.

2.3. Algorithm Frequent Pattern Growth

Before the FP-Growth Algorithm was discovered, analysis towards items which frequently appeared & used was Apriori Algorithm. The principle of Apriori Algorithm is collecting single item to find out the biggest item from whole items. After obtaining paired items are counted for each itemset. Association rule candidates that might be obtained through minimum support value & minimum confidence value.

$$\text{Support (x)} = \frac{\sum \text{Trans Containing } x}{\sum \text{Trans}} + 100\%$$

$$\text{Confidence } P(x|y) = \frac{\sum \text{Trans Containing } x \text{ dan } y}{\sum \text{Trans Containing } x} + 100\%$$

In mining knowledge in transaction data collection, Apriori algorithm just possesses two phases, (1) discovering pattern with high frequency of item combination number by considering minimum support, (2) creating association rule between items by considering minimum confidence.

Algorithm in other Association Rule Mining that can be used to obtain association rule in a group of data are Predictive Apriori Algorithm & Tertius Algorithm. Apriori algorithm is chosen to solve problems, because Apriori algorithm produce better association rule than Predictive Apriori & Tertius Algorithm. (5) While FP-Growth Algorithm is used as an alternative to determine data collection of frequent itemset sample data. FP-Growth Algorithm has difference in which it applies item set structure arrangement shape like a tree which is called frequent pattern tree (FP-Tree). FP-Tree construct frequent item set by using candidate generation just like in Apriori Algorithm. With this tree, FP-Growth algorithm become faster in producing association rule compared to Apriori Algorithm.

FP-Growth stages are divided into three: (1) The stages to construct conditional pattern base which is part of database that contains start-pattern & end-pattern trajectory. (2) the stage to construct tree structure conditional. In this stage, support count from each item in each conditional pattern base is counted, then each item that has more support count or equal with minimum support count will be constructed with conditional FP-Tree. (3) The stage to find out frequent item set. After the process of constructing tree structured pattern from a collection of transaction data, FP-Growth Algorithm is applied to figure out significant frequent itemset. In this stage, frequent item sets will be obtained by combining item for each FP-Tree conditional. If it is not a single trajectory, reclusive FP-Growth construction is done.

2.4. Association Rule

Association rule is a process in data mining to produce all rules of association correlation that meets the requirements are used to obtain rules of association correlation between products by determining value limit. In other words, Association Rule mining is a procedure to find the correlation between items in a dataset. Algorithm is started with looking for frequent itemset, that is the most frequent combination in an itemset it must fulfil the minimum support. In this stage, the search of item combination that fulfil the minimum requirement of support value in database will be done. To obtain support value from item A&B, these formulae can be used:

$$\text{Support (A, B)} = P(A \cap B)$$

$$\text{Support (A, B)} = \frac{\sum \text{Trans Containing A \& B}}{\sum \text{Transaction}}$$

In market basket analysis, the purchase pattern from consumers by finding out correlation pattern between different items done by consumers. It is expected that beside the consumers purchase pattern that is commonly done. We can also figure out new patterns as the number of goods purchasing transaction is increasing.

2.5. Itemset and Frequent Itemset

Itemset is collection from one or more items in a transaction, while K itemset is a collection of items that contains some K item. Frequently itemset is the number of transactions that contain certain item collection. While frequent itemset is a collection of items that happen the least with certain number, symbolized by Φ . Φ is the minimum limit from the chosen item collection. For instance, $\Phi = 2$, the itemset that happen more than twice is called frequent itemset. While, FK value is the collection of the whole frequent itemset which consist of K-item (Siburian, 2014).

2.6. Support, Confidence and Lift Ratio

In the associative correlation, there are antecedent and consequent Antecedent represent the part which is called “if”, and consequent represents the part called “then”. In this process, antecedent and consequent are item sets that have no correlation to each other. Set of rules should contain rules that have strong enough correlation with dependence level between items that exist in antecedent item and consequent item. The power measurement of this association correlation rule, so support and confidence measurement are used (Siburian, 2014). The characteristic of support is a very important measurement in association analysis. While confidence is used to measure correlation certainly value between items in association rule. For the rule $A \rightarrow B$, high confidence value shows the number of B that appear in the transaction that contains A. Confidence also gives the way to figure out association rule efficiently (Prasetyo, 2012). Lift ratio is important parameter other than support and confidence in association rule. Lift ratio measures how important is the rule that has been formed according to support & confidence.

$$\text{Lift (A, B)} = (\text{Support A} \times \text{Support B}) / (\text{Support } A \cap B)$$

A transaction is called valid if it has lift or improvement value that has more than one value. It means in the transaction, product A and B are really purchased by consumers at the same time (Zahedi, 2012).

3. Result and Analysis

In this part, the result and the analysis are explained by using analysis device Rapidminer. Here is the process of cultivating sales sample data to discover knowledge about the products purchased at the same time & those which are purchased the most by consumers.

Figure 3: MBA Datamining Process Design

- Retrieve Data Sales are prepared in the local repository that is produced through data transformation process from Anterah Store's retail sales sample collection.
- Aggregate parameters is used to choose aggregate attribute, the number of sales that are grouped according to invoice attribute & product title.
- Pivot functions is used to rotate sample data and to group them as single sample. This grouping is done for invoice attribute & is sorted according to product title attribute.
- Set Role is used to change the role from one or more attributes, the attribute's title that will be changed is invoice & target role as identifier (id).
- FP-Growth is used to calculate the frequent itemset from sample collection by using FP-Tree data structure it is determined that the number of minimum itemset is 2, max number of retries 15, positive value true, min support 0.0015, max item 15.
- Create association rule, used to generate a set of association rules set that is taken from frequent itemset. Confidence value criteria with minimum value 0.6.

3.1. Results of FP-Growth Analysis and Association Rule

The frequent itemset analysis for a month transaction produces 61 combination from 2 item of frequent itemset. It can be seen in the table 2, 3 combination from 3 product items as seen the table 3 and it produce 16 association rules as shown in the table 4.

In the table 2, it is shown that the result of market basket analysis with combination of 2 items which are frequently purchased at the same time. This result can be used as the principle of product arrangement in the display window near to each other. It is because those products are usually bought at the same time so consumers can find the products they want to buy easily. Furthermore, it can also be used as the basis of stock determination for the product that frequently appear in relevant number. While for the products that rarely appear and sales promotion for them. The result of the analysis shows that there are 61 combination from two products that are purchased at the same time. They are products like granulated sugar, Indomie (instant noodle), toothpaste, milk, soap, dish soap and several snacks.

No	Support	Product Item 1	Product Item 2
1	0.003	GRANULATED SUGAR 1 KG	INDOMIE GORENG
2	0.003	GRANULATED SUGAR 1 KG	CHICKEN EGG
3	0.004	GRANULATED SUGAR 1 KG	SUNLIGHT LIME REF 800ML
4	0.003	GRANULATED SUGAR 1 KG	MIE SEDAP GORENG
5	0.002	GRANULATED SUGAR 1 KG	INDOMIE CHICKEN BAWANG
6	0.002	GRANULATED SUGAR 1 KG	PEPSODENT 12 JAM WHITE 190G
7	0.002	GRANULATED SUGAR 1 KG	INDOMIE CHICKEN SPESIAL
8	0.002	GRANULATED SUGAR 1 KG	MIE SEDAP SOTO
9	0.003	GRANULATED SUGAR 1 KG	MIE SEDAP BASO SPESIAL 77G
10	0.002	GRANULATED SUGAR 1 KG	MIE SEDAP CHICKEN SPESIAL
11	0.002	GRANULATED SUGAR 1 KG	TEH GOPEK MELATI CELUP 50G
12	0.002	GRANULATED SUGAR 1 KG	NUVO FAMILY SOAP MERAH 80G
13	0.002	GRANULATED SUGAR 1 KG	TEH SOSRO CELUP TB 30
14	0.002	GRANULATED SUGAR 1 KG	COFFEE LUWAK WHITE KOFFIE 5X20G
15	0.002	GRANULATED SUGAR 1 KG	COFFEE LUWAK 165
16	0.002	INDOMIE GORENG	CHICKEN EGG
17	0.002	INDOMIE GORENG	MIE SEDAP GORENG
18	0.005	INDOMIE GORENG	INDOMIE CHICKEN BAWANG
19	0.003	INDOMIE GORENG	INDOMIE CHICKEN SPESIAL

No	Support	Product Item 1	Product Item 2
20	0.002	INDOMIE GORENG	MIE SEDAP BASO SPESIAL 77G
21	0.002	INDOMIE GORENG	INDOMIE GORENG SAMBAL MATAH 85G
22	0.003	INDOMIE GORENG	INDOMIE GRG RENDANG PDS MEDAN 82GR
23	0.002	INDOMIE GORENG	INDOMIE KARI CHICKEN
24	0.002	HAPPY NAPPY SMART PANTZ XL 26	JOLLY FACIAL SP SINGLE 250'S
25	0.002	SUNLIGHT LIME REF 800ML	PEPSODENT 12 JAM WHITE 190G
26	0.002	MIE SEDAP GORENG	INDOMIE CHICKEN BAWANG
27	0.002	MIE SEDAP GORENG	INDOMIE CHICKEN SPESIAL
28	0.004	MIE SEDAP GORENG	MIE SEDAP SOTO
29	0.002	MIE SEDAP GORENG	MIE SEDAP BASO SPESIAL 77G
30	0.004	MIE SEDAP GORENG	MIE SEDAP CHICKEN SPESIAL
31	0.003	MIE SEDAP GORENG	MIE SEDAP CHICKEN BAWANG
32	0.002	INDOMIE CHICKEN BAWANG	INDOMIE CHICKEN SPESIAL
33	0.002	PEPSODENT 12 JAM WHITE 190G	SO KLIN SOFTERTGENT PURPLE 900G
34	0.002	SGM 4 AKTIF M 1000	SGM 4 AKTIF V 1000
35	0.002	SGM 3 EKSPLOR MADU 400	SGM 3 EKSPLOR MADU 150
36	0.002	SGM 3 EKSPLOR MADU 400	SGM 4 AKTIF M 400
37	0.002	SGM 1 ANANDA 150 NEW	SGM 2 ANANDA 150
38	0.002	SGM 1 ANANDA 150 NEW	DC 3+ M 200
39	0.003	MIE SEDAP SOTO	MIE SEDAP CHICKEN SPESIAL
40	0.003	LIFEBUOY SOAP TOTAL 10 85G	LIFEBUOY SOAP LEMON FRESH 85G
41	0.002	MIE SEDAP BASO SPESIAL 77G	MIE SEDAP CHICKEN SPESIAL
42	0.004	INDOMIE GORENG SAMBAL MATAH 85G	INDOMIE TENGLKENG 75GR
43	0.002	NUVO FAMILY SOAP HIJAU 80G	NUVO FAMILIY SOAP MERAH 80G
44	0.004	NUVO FAMILY SOAP HIJAU 80G	NUVO FAMILIY SOAP KUNING 80G
45	0.003	NUVO FAMILY SOAP HIJAU 80G	NUVO FAMILIY SOAP BIRU 80G
46	0.002	NUVO FAMILY SOAP HIJAU 80G	NUVO FAMILY SOAP COOL 80G
47	0.002	GERY CHOCOLATOS CHOCO DRINK 10X28G	GOOD DAY VANILA 10X20
48	0.002	NBS EKONOMIS KH 120G	NBS EKONOMIS BM 120G
49	0.002	SO KLIN LIQ VIOLET 6X26ML	SO KLIN LIQ AB PARFUME SACHET 6X30ML
50	0.002	SO KLIN LIQ VIOLET 6X26ML	SO KLIN LIQ SOFTERTGENT 6X28ML
51	0.003	NUVO FAMILIY SOAP MERAH 80G	NUVO FAMILIY SOAP KUNING 80G
52	0.002	NUVO FAMILIY SOAP MERAH 80G	NUVO FAMILIY SOAP BIRU 80G
53	0.002	DC 1+ M 200	DC 3+ M 200
54	0.002	SGM 2 ANANDA 150	DC 3+ M 200
55	0.002	NUVO FAMILIY SOAP KUNING 80G	NUVO FAMILIY SOAP BIRU 80G
56	0.002	CHIL GO COKLAT BTL 140ML	CHIL GO VANILA BTL 140ML
57	0.002	INDOMILK SKM PUTIH 6X45GR	INDOMILK SKM COKLAT 6X45GR
58	0.002	ULTRA KRIMER CAP SAPI CHO 388 KLNG	CAP ENAAK SKM PUTIH 375G
59	0.002	INDOMILK SUSU CAIR STRAW 190	INDOMILK SUSU CAIR MELON 200
60	0.002	CHIKI BALL KEJU 12 G	CHIKI BALL KALDU CHICKEN 14 GR
61	0.002	ZEE UHT STRAWBERRY 200ML	ZEE UHT SWIZZ CHOCO 200ML

Table 2: Frequent Itemset of 2 item Combinations

In the table 3, it is shown that the result of market basket analysis with 3 items combination which are frequently bought at the same time. It is found in the analysis that 3 combinations from three products which are purchased at the same time in which Mie Sedaap, SGM Milk, and Nuvo Soap are the most purchased at the same time. The highest lift value with lift value 302.533. SUSU CAP ENAK SKM White 375gr with Ultra Milk Creamer Cap Sapi 388 (Canned).

No	Support	Product Item 1	Product Item 2	Product Item 3
1	0.003	MIE SEDAP GORENG	MIE SEDAP SOTO	MIE SEDAP CHICKEN SPESIAL
2	0.002	SGM 1 ANANDA 150 NEW	SGM 2 ANANDA 150	DC 3+ M 200
3	0.002	NUVO FAMILY SOAP HIJAU 80G	NUVO FAMILIY SOAP MERAH 80G	NUVO FAMILIY SOAP KUNING 80G

Table 3: Frequent Itemset of 3 items Combinations

In the table 4. The result of market basket analysis show that for the products with association correlation from two items with support value, confidence, & lift ratio that shows that both products are really purchased at the same time.

No	Premis	Conclusion	Support	Convidence	Lift
1	ULTRA KRIMER CAP SAPI CHO 388 KLNG	CAP ENAAK SKM PUTIH 375G	0.002	0.625	202.589
2	NUVO FAMILIY SOAP KUNING 80G	NUVO FAMILY SOAP HIJAU 80G	0.004	0.667	100.844
3	NUVO FAMILIY SOAP BIRU 80G	NUVO FAMILY SOAP HIJAU 80G	0.003	0.667	100.844
4	ZEE UHT STRAWBERRY 200ML	ZEE UHT SWIZZ CHOCO 200ML	0.002	0.667	302.533
5	MIE SEDAP GORENG, MIE SEDAP SOTO	MIE SEDAP CHICKEN SPESIAL	0.003	0.667	100.844
6	NUVO FAMILIY SOAP MERAH 80G, NUVO FAMILIY SOAP KUNING 80G	NUVO FAMILY SOAP HIJAU 80G	0.002	0.667	100.844
7	CAP ENAAK SKM PUTIH 375G	ULTRA KRIMER CAP SAPI CHO 388 KLNG	0.002	0.714	202.589
8	MIE SEDAP GORENG, MIE SEDAP CHICKEN SPESIAL	MIE SEDAP SOTO	0.003	0.75	94.542
9	COFFEE LUWAK 165	GRANULATED SUGAR 1 KG	0.002	0.8	21.61
10	ZEE UHT SWIZZ CHOCO 200ML	ZEE UHT STRAWBERRY 200ML	0.002	0.8	302.533
11	SGM 1 ANANDA 150 NEW, SGM 2 ANANDA 150	DC 3+ M 200	0.002	0.8	201.688
12	NUVO FAMILY SOAP HIJAU 80G, NUVO FAMILIY SOAP MERAH 80G	NUVO FAMILIY SOAP KUNING 80G	0.002	0.8	151.266
13	MIE SEDAP CHICKEN BAWANG	MIE SEDAP GORENG	0.003	0.875	66.179
14	MIE SEDAP SOTO, MIE SEDAP CHICKEN SPESIAL	MIE SEDAP GORENG	0.003	1	75.633
15	SGM 1 ANANDA 150 NEW, DC 3+ M 200	SGM 2 ANANDA 150	0.002	1	189.083
16	SGM 2 ANANDA 150, DC 3+ M 200	SGM 1 ANANDA 150 NEW	0.002	1	119.421

Table 4: Association Rule

4. Conclusion

Association rule mining algorithm can be used for decision making in determining promotional pricing, stock, and for helping product arrangement in the store.

The test result using market basket analysis in the table 2, frequent itemset with two items combination that are frequently purchased at the same time. According to combination that shows 61 items with pairs, 2 product items that appear at the same time can be used as the basis of product arrangement in the store. That combination of two items can be arranged nearby and product item arrangement is placed in the main location so that consumers are able to find the products easily. In the end, it can shorten the length of time to shop. In the result of the frequent item analysis, it is found 61 combination of two products which are purchased at the same time, such as: granulated sugar, instant noodle, toothpaste, milk, soap, dish soap, and some snack

Combination of 3 items that is shown by result of market basket analysis in the table 3. Frequent itemset with combination of three items shows the combination of three product items that are frequently purchased at the same time. The product is Mie Sedaap, SGM Milk and Nuvo soap. They are often bought at the same time. The highest lift value is Zee UHT Strawberry 200ml with Zee Swizz Choco 200ml UHT with lift ratio value 302,533. Susu Cap Enak SKM White 375 Grams with Ultra Cream Milk Cap Sapi Cho 388 (canned).

The result of market basket analysis can be used as the basis of stock determining for the products that frequently appear in an adequate number. While, for the products that don't frequently appear we need to design sales promotion strategy to make those products become more popular among customer.

After the results of this study throughout 2019, an increase in sales turnover was significant by approximately 7%.

Omset	2017	2018	2019
Jan – Apr	5.502.244.234	5.624.954.654	5.956.365.834
Mei – Agt	5.678.345.734	5.736.886.241	6.135.355.924
Sep - Des	5.834.785.752	6.123.563.681	6.435.375.934

Table 5

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