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Association Pattern Analysis of Production Results Using the Apriori Algorithm

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Abstract
This study aims to analyze association patterns in production data at CV. Sinar Agung Teknik using the Apriori algorithm. The company faces challenges in identifying co-produced product relationships, which complicates production pattern recognition. The research adopts the Knowledge Discovery in Databases (KDD) approach, comprising data selection from three months of daily production, data cleaning, transformation into transactional format, application of the Apriori algorithm, and result visualization. Key parameters applied in the mining process include support, confidence, and lift. The analysis was conducted from 1-itemset to 5-itemset combinations to determine product co-occurrence frequencies. The results revealed several significant association rules. One notable rule shows that the production of Karet Membran TT, Panel Pressure Destec, and Plat C Starcam is followed by Join Tuas Starcam and Karet Membran COM, with a confidence of 90% and a lift value of 2.25. A lift greater than 1 indicates a strong correlation among the products. These findings are expected to provide data-driven insights that can support decision-making in warehouse management, inventory control, and the strategic arrangement and retrieval of products.

Keywords— Apriori Algorithm, Association Rules, KDD Process, Production Data, Pattern Analysis

1 Introduction

In the midst of increasing competition in the manufacturing industry, operational efficiency and accurate decision-making have become crucial factors for maintaining a company's competitive advantage . CV. Sinar Agung Teknik produces components such as *plat C*, *join tuas*, and *karet membran*, but still faces difficulties in identifying the relationships between products that are often manufactured together. As a result, production patterns cannot be fully discovered or used effectively [1].

Not having proper analysis of product associations can lead to inefficient warehouse and inventory management potentially causing overstock or stockouts that disrupt operations and increase costs [2]. To solve this issue, data mining methods especially association rule techniques like the Apriori algorithm have proven to be effective in finding hidden patterns from historical data in various sectors, including manufacturing and e-commerce [3]. This research uses daily production data collected over a period of three months in 2024 from CV. Sinar Agung Teknik, located in Bekasi. The data has been converted into a transaction format to support further analysis and association rule mining.

This research uses the Apriori algorithm approach, which has been widely applied in the manufacturing industry to discover association rules between items based on three key parameters: support, confidence, and lift [4]. These parameters help measure how frequently items appear together, the strength of the relationship between items, and how much more significant the relationship is compared to random occurrences.

The Apriori algorithm is chosen in this research because it can generate rules that are easy to interpret, making it easier for management to understand which products are often produced together. This clarity supports better decision-making in areas such as production planning, inventory control, and warehouse efficiency. In addition, Apriori is relatively simple to implement and can be integrated with existing data analysis systems, making it a

practical and effective solution for analyzing production patterns[5]. By identifying recurring production patterns, the company is expected to improve stock management efficiency, warehouse operations, and the development of more accurate and data-driven distribution strategies.

2 Research methods

This research uses the Apriori algorithm approach to identify patterns in production outcomes. Through this method, an analysis of product associations is carried out to discover items that frequently appear together. The analysis follows the *Knowledge Discovery in Databases* (KDD) process[6], which consists of several main stages: data selection, preprocessing, transformation into transaction format, application of the Apriori algorithm, and finally, evaluation and interpretation of the results [7].

2.1 *Data Selection*

The data used in this research consists of daily production records over a three-month period in 2024. This three-month timeframe was selected to simplify the scope of analysis while still providing a sufficient overview of production patterns. The selected data includes attributes such as the production date and the names of products manufactured on each day, which are then used in the association analysis process[1].

2.2 *Preprocessing*

This stage aims to clean the raw production data before further analysis is conducted. The cleaning process involves removing duplicate entries and eliminating invalid data, such as incorrect formats or inconsistent values. Through this step, the data becomes more accurate, consistent, and suitable for analysis[8].

2.3 *Transformation*

The production data was then transformed to fit the needs of association analysis. At first, the data was recorded by individual product and date. It was later changed into a transaction format, where each row represents one day of production and includes all products made on that day. This format makes it easier to find relationships between products that are often produced together.

The transaction-format data was then converted into a binary format by representing the presence of a product with the number 1 and its absence with the number 0. This step is necessary because the Apriori algorithm requires numerical input to perform association analysis.

2.4 *Data Mining*

The Apriori algorithm was then applied to identify relationships between products based on three months of production data. The binary-formatted data was used to generate itemsets, starting from 1-itemset up to 5-itemset. Association rules were then created based on the values of support, confidence, and lift. The results of this process provide insights into which products are frequently produced together, which can be used to support better decision-making[9].

- Support is a measure that shows how often an item or a group of items appears in all transactions[10]. This metric is used to determine whether an item or itemset is frequent enough to be used as the basis for calculating confidence (for example, how often items A and B appear together in a transaction).

$$Support\ (A) = \frac{Jumlah\ Transaksi\ yang\ mengadung\ A}{Total\ transaksi} \quad (1)$$

$$Support\ (A,B) = \frac{Jumlah\ Transaksi\ yang\ mengadung\ A\ dan\ B}{Total\ transaksi} \quad (2)$$

- Confidence is an indicator that describes the strength of the conditional relationship between two items. For example, it shows how likely it is that production item B will appear if item A is also found[11].

$$Confidence(A \rightarrow B) = \frac{Support\ (A,B)}{Support\ (A)} \quad (3)$$

- The lift ratio is a metric used to measure the strength of an existing association rule. The result of the lift value can be used as a reference to determine the validity of the rule[2].

$$Lift\ (A\ \rightarrow B) = \frac{Support\ (A,B)}{Support\ (A) \times Support\ B} \quad (4)$$

2.5 *Evaluation*

The generated association rules were evaluated using three metrics: support, confidence, and lift. Support measures how often a group of products appears together in the production data. Confidence indicates the likelihood that one product will appear if another product is also produced on the same day. Lift helps determine whether the relationship between the products is truly meaningful or just a coincidence. The results of this evaluation provide a clearer picture of which products tend to occur together and how strong their relationships are, making them useful as a basis for decision-making[12].

2.6 *Knowledge Presentation*

The analysis results are presented in the form of bar charts to make them easier to understand. These charts show how frequently and how strongly products are associated with one another based on their support, confidence, and lift values[13].

3 Results and Discussion

3.1 *Data Selection*

The data analyzed in this research comes from production records over a three-month period in 2024. This time frame was chosen to simplify the analysis process while still providing a sufficient overview of production patterns. The data was processed and analyzed to identify association patterns between products. The dataset includes several attributes, such as the production date, which indicates when the production took place, and the product name, which specifies the type of product produced on that date.

3.2 *Preprocessing*

Data cleaning was performed to prepare the dataset for analysis. This process included removing duplicate records and eliminating data that was inconsistent or did not match the required format.The initial dataset consisted of daily production records, which included information such as the date, product name, and quantity produced per day. At this point, the data was still raw and had not undergone any cleaning. Therefore, preprocessing was necessary to remove duplicates and inconsistencies before conducting further analysis.

Table 1. Data before cleaning

No	Tanggal	Nama Produk	Jumlah Produk
1	02/01/2024	Plat C Starcam	8705
2	03/01/2024	Plat C Starcam	8015
3	04/01/2024	Plat C Starcam	7951
4	05/01/2024	Plat C Starcam	8385
5	06/01/2024	Plat C Starcam	8505

The results from this process are presented after additional time-related attributes were added to the data, such as month, week number, and day. These additions were made to simplify and support the analysis process.

Table 2. Data after cleaning

No	Tanggal	Nama Produk	Jumlah Produk	Bulan	Minggu	Hari
1	02/01/2024	Plat C Starcam	8705	Januari	1	Selasa
2	03/01/2024	Plat C Starcam	8015	Januari	1	Rabu
3	04/01/2024	Plat C Starcam	7951	Januari	1	Kamis
4	05/01/2024	Plat C Starcam	8385	Januari	1	Jum'at

5	06/01/2024	Plat C Starcam	8505	Januari	1	Sabtu

3.3 *Transformation*

The production data was further processed through a transformation stage to fit the requirements of association analysis. Data that was originally recorded per product and per date was converted into a transaction format.

Table 3. Data after transformation

Tanggal	Nama Produk	Jumlah Produksi
02/01/2024	Plat C Starcam	8705
03/01/2024	Plat C Starcam	8015
04/01/2024	Plat C Starcam	7951
05/01/2024	Plat C Starcam	8385
06/01/2024	Plat C Starcam	8505
09/01/2024	Plat C Starcam	8210
16/01/2024	Plat C Starcam	8838
17/01/2024	Plat C Starcam	8496
…	…	…
20/08/2024	Karet Membran TT	3897
21/08/2024	Karet Membran TT	4370
22/08/2024	Karet Membran TT	4294
23/08/2024	Karet Membran TT	3892
24/08/2024	Karet Membran TT	3706
26/08/2024	Karet Membran TT	3514
27/08/2024	Karet Membran TT	4357

The production data, which was previously recorded per product and per date, was then reorganized into a transaction format. the result of this transformation process. Each row represents a single daily production transaction consisting of several products produced on the same day. This format is used to simplify the association analysis and help identify relationships between products that frequently appear together.

Table 4. Result of Production Data Transformation into Transaction Format

Tanggal	Produk
02/01/2024	Plat C Starcam, Karet Membran TT, Panel Pressure Destec, Karet Membran COM, Join Tuas Starcam, Plat C COM
03/01/2024	Plat C Starcam, Karet Membran COM, Karet Membran TT, Panel Pressure Destec, Plat C COM, Join Tuas Starcam
04/01/2024	Plat C Starcam
05/01/2024	Plat C COM, Karet Membran COM
06/01/2024	Plat C Starcam, Karet Membran COM, Plat C COM, Panel Pressure Destec, Join Tuas Starcam
08/01/2024	Join Tuas Starcam, Karet Membran COM
09/01/2024	Plat C Starcam, Plat C COM, Join Tuas Starcam
10/01/2024	Panel Pressure Destec, Plat C COM, Karet Membran COM
…	…
25/03/2024	Karet Membran TT, Panel Pressure Destec
26/03/2024	Panel Pressure Destec, Plat C Starcam, Karet Membran COM, Plat C COM
27/03/2024	Karet Membran COM, Plat C Starcam, Karet Membran TT, Panel Pressure Destec, Join Tuas Starcam

28/03/2024	Panel Pressure Destec, Plat C COM, Karet Membran TT, Plat C Starcam, Join Tuas Starcam
30/03/2024	Panel Pressure Destec, Plat C COM, Join Tuas Starcam

After the data was converted into a transaction format, the next step was to transform it into binary form. This process was necessary because the association algorithm used in this study requires the data to be in the form of 1s and 0s. A value of 1 indicates that a product appears in the transaction, while a value of 0 means the product does not appear.

Table 5. Result of Data Transformation into Binary Format

NO	Join Tuas Starcam	Karet Membran COM	Karet Membran TT	Panel Pressure Destec	Plat C COM	Plat C Starcam
0	1	1	1	1	1	1
1	1	1	1	1	1	1
2	0	0	0	0	0	1
3	0	1	0	0	1	0
4	1	1	0	1	1	1
5	1	1	0	0	0	0
..	…	…	..	…	…	..
70	0	0	1	1	0	0
71	0	1	0	1	1	1
72	1	1	1	1	0	1
73	1	0	1	1	1	1
74	1	0	0	1	1	0

3.4 *Data Mining*

In this study, the researcher applied a data mining approach using the Apriori algorithm to uncover associations among production items. The analysis was conducted using three months of production data, which was considered sufficient to represent the company's overall production patterns. The process began by transforming the data into a transaction format, where each transaction represented a group of products manufactured on the same day. The Apriori algorithm was then used to identify item combinations that frequently occur together based on support values, and to generate association rules by calculating confidence and lift. The outcome of this process was a set of association rules between products, offering insights into production patterns. These findings can be used as a foundation for decision-making in warehouse management and inventory planning.

The result of the 1-itemset formation shows a list of individual products that appear one by one in each transaction. This stage serves as the initial basis for observing the frequency of each product before proceeding to the formation of itemset combinations involving more than one product.

The result analysis of 1-itemsets based on support values shows that the product with the highest support is Plat C COM (66.67%), followed by Plat C Starcam and Join Tuas Starcam. On the other hand, Karet Membran TT has the lowest support value at 53.33%.

Table 6. Itemset 1

No	Produk	Support (%)
1	Plat C COM	66.67
2	Plat C Starcam	65.33
3	Join Tuas Starcam	62.67
4	Panel Pressure Destec	60
5	Karet Membran COM	57.33
6	Karet Membran TT	53.33

The process continues with the formation of 2-itemsets, which are combinations of two products that appear together in a single production transaction. The result of this process shows each row as a combination of itemsets that co-occur in the transaction data. This stage is carried out to identify product combinations that potentially have associative relationships, before moving forward to the association rule generation stage for further analysis.

The 2-itemset results show relationships between pairs of products within a single transaction, based on support and confidence values. The combination with the highest confidence is Karet Membran COM and Plat C COM, with a confidence of 81.4% and a support of 46.67%.

Table 7. Itemset 2

No	Aturan Asosiasi Produksi	Support (%)	Confidence (%)
1	JIKA memproduksi Karet Membran COM MAKA juga memproduksi Plat C COM	46.67	81.4
2	JIKA memproduksi Karet Membran COM MAKA juga memproduksi Panel Pressure Destec	44	76.74
3	JIKA memproduksi Karet Membran COM MAKA juga memproduksi Plat C Starcam	44	76.75
4	JIKA memproduksi Panel Pressure Destec MAKA juga memproduksi Plat C COM	45.33	75.56
5	JIKA memproduksi Karet Membran TT MAKA juga memproduksi Plat C COM	40	75

The association rules generated from 3-itemset combinations that frequently appear together in production transactions are presented in an "If a transaction produces …, then it also produces …" format. This structure highlights the relationships among multiple products within a single transaction. The rules were derived from the frequency with which these product combinations occur in the transaction data.

The association analysis of 3-itemsets reveals relationships between three items that frequently appear together in a single transaction. These patterns are measured using three key metrics: support, confidence, and lift. One of the strongest rules identified is *Panel Pressure Destec, Plat C Starcam → Karet Membran COM*, which has a confidence of 90% and the highest lift value of 1.57, indicating a strong relationship among these products. All the rules in the table show lift values greater than 1, meaning that the products frequently appear together and are strongly associated, rather than occurring by chance.

Table 8. Itemset 3

No	Aturan Asosiasi Produksi	Support (%)	Confidence (%)	Lift
1	JIKA memproduksi Panel Pressure Destec, Plat C Starcam MAKA juga memproduksi Karet Membran COM	36.00	90.00	1.57
2	JIKA memproduksi Karet Membran COM MAKA juga memproduksi Panel Pressure Destec, Plat C Starcam	36.00	62.79	1.57
3	JIKA memproduksi Karet Membran COM, Karet Membran TT MAKA juga memproduksi Join Tuas Starcam	29.33	91.67	1.46
4	JIKA memproduksi Karet Membran TT, Karet Membran COM MAKA juga	28.00	87.50	1.46

	memproduksi Panel Pressure Destec			
5	JIKA memproduksi Join Tuas Starcam MAKA juga memproduksi Karet Membran TT, Karet Membran COM	29.33	46.67	1.46

After generating the 3-itemset association rules, the analysis continued with 4-itemset combinations. The results show several 4-itemsets found in the transaction data, indicating associations among four items that frequently appear together in a single transaction. As the number of items in a rule increases, the resulting patterns become more specific, although their frequency tends to be lower.

The 4-itemset association results show relationships among four products within a single transaction. The rule with the highest confidence, 79.17%, is found in the combination of *Karet Membran TT, Karet Membran COM, Plat C Starcam,* and *Panel Pressure Destec*, with a lift value of 1.98. This indicates a strong association among these four products, which frequently appear together.

Table 9. Itemset 4

No	Aturan Asosiasi Produksi	Support (%)	Confidence (%)	Lift
1	JIKA memproduksi Karet Membran TT, Karet Membran COM MAKA juga memproduksi Plat C Starcam, Panel Pressure Destec	25.33	79.17	1.98
2	JIKA memproduksi Plat C Starcam, Panel Pressure Destec MAKA juga memproduksi Karet Membran TT, Karet Membran COM	25.33	63.33	1.98
3	JIKA memproduksi Plat C Starcam, Panel Pressure Destec MAKA juga memproduksi Karet Membran COM, Join Tuas Starcam	30.67	76.67	1.92
4	JIKA memproduksi Karet Membran COM, Join Tuas Starcam MAKA juga memproduksi Plat C Starcam, Panel Pressure Destec	30.67	76.67	1.92
5	JIKA memproduksi Plat C Starcam, Karet Membran TT MAKA juga memproduksi Karet Membran COM, Join Tuas Starcam	26.67	74.07	1.85

The analysis continued with the formation of association rules from 5-itemsets identified in the production transaction data. These rules represent patterns of association among five products that frequently appear together in a single transaction. Although 5-itemset combinations occur less frequently than those with fewer products, the patterns formed tend to indicate stronger relationships among the products involved.

The results of the 5-itemset association show patterns of relationships among five products. The first rule has the highest confidence of 90% and a lift value of 2.25, indicating a strong connection between the products. All rules in the table have lift values greater than 2, which suggests that the relationships among the items are both significant and consistent.

Table 9. Itemset 5

No	Aturan Asosiasi Produksi	Support (%)	Confidence (%)	Lift
1	JIKA memproduksi Karet Membran TT, Panel Pressure Destec, Plat C Starcam MAKA juga memproduksi Join Tuas Starcam, Karet Membran COM	24.00	90.00	2.25
2	JIKA memproduksi Join Tuas Starcam, Karet Membran COM MAKA juga memproduksi Karet Membran TT, Panel Pressure Destec, Plat C Starcam	24.00	60.00	2.25
3	JIKA memproduksi Karet Membran TT, Karet Membran COM MAKA juga memproduksi Join Tuas Starcam, Panel Pressure Destec, Plat C Starcam	24.00	75.00	2.16

No	Aturan Asosiasi Produksi	Support (%)	Confidence (%)	Lift
4	JIKA memproduksi Join Tuas Starcam, Panel Pressure Destec, Plat C Starcam MAKA juga memproduksi Karet Membran TT, Karet Membran COM	24.00	69.23	2.16
5	JIKA memproduksi Karet Membran TT, Panel Pressure Destec MAKA juga memproduksi Join Tuas Starcam, Plat C Starcam, Karet Membran COM	24.00	69.23	2.08

The analysis of product frequency in transactions is based on data collected over a three-month period. This duration was chosen to simplify the analytical process while still providing a representative view of the production patterns. The results offer insight into how often each product appears in transactions. Frequently occurring products often have associations with other items. Therefore, this information can be used to better understand product relationships and support the development of a more structured and efficient inventory management system, aligned with the observed patterns.

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📊 Frekuensi Kemunculan Produk dalam Transaksi (Gabungan 3 Bulan):
- Plat C Starcam: 49 kali
- Karet Membran TT: 40 kali
- Panel Pressure Destec: 45 kali
- Karet Membran COM: 43 kali
- Join Tuas Starcam: 47 kali
- Plat C COM: 50 kali
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Figure 1. Frequency of Product

3.5 *Evaluation*

The evaluation was conducted on the association rules based on the previously calculated metrics in the data mining stage: support, confidence, and lift. At this stage, the strength of product relationships was assessed using these three key measures. Support indicates how frequently specific products appear together in the dataset. Confidence reflects the likelihood that one product will appear if another related product is present in the same transaction. Lift, on the other hand, determines whether the relationship between products is truly significant or merely coincidental.

The results of this evaluation—from 1-itemset to 5-itemset—provide insights into how strongly various products are associated with each other. These findings are valuable in helping the company better understand production patterns and make informed decisions for warehouse arrangement and inventory planning.

1. The analysis of the 1-itemset results shows that *Plat C COM* has the highest frequency of appearance (66.67%), followed by *Plat C Starcam* (65.33%) and *Join Tuas Starcam* (62.67%). These products appear most frequently in the transactions during the analysis period. A high support value indicates that these items are regularly produced and should become the focus for inventory and warehouse management.
2. In the 2-itemset analysis, rules with strong support and confidence were observed. The highest confidence (81.4%) was found in the pattern: *If Karet Membran COM, then Plat C COM*, followed by *If Karet Membran COM, then Panel Pressure Destec and Plat C Starcam* with 76.74% confidence. These patterns suggest that the presence of *Karet Membran COM* often coincides with those products. The support values for these combinations exceed 40%, meaning that the relationships are both strong and frequent, making them valuable for decision-making in inventory planning.
3. In the 3-itemset results, the strongest rule was: *If Panel Pressure Destec and Plat C Starcam, then Karet Membran COM*, with 90% confidence and a lift of 1.57. This means that when the two items appear, *Karet Membran COM* is also highly likely to be present. A lift above 1 confirms a strong and meaningful relationship.
4. The 4-itemset findings reveal that the combination of *Karet Membran TT* and *Karet Membran COM* often co-occurs with *Plat C Starcam* and *Panel Pressure Destec*. This rule has a confidence of 79.17% and a lift value of 1.98, suggesting a very strong connection among the four products. This insight can be used to improve warehouse organization and stock control, especially by grouping commonly associated items together.

5. Finally, the 5-itemset analysis discovered a highly significant rule: *If Karet Membran TT, Panel Pressure Destec, and Plat C Starcam*, then *Join Tuas Starcam and Karet Membran COM* will also appear. This rule has a confidence of 90% and a lift of 2.25, showing a very strong association. These results are valuable for developing more efficient stock management strategies and optimizing product placement in the warehouse.

3.6 *Knowledge Presentation*

The results of the association analysis were transformed into actionable insights to support decision-making processes. The information derived from this analysis is utilized to enhance warehouse management and inventory control. These insights help identify which products are commonly produced together, enabling the company to improve stock planning and optimize storage strategies.

The following is a summary of the association analysis results, ranging from 1-itemset to 5-itemset, which reveal patterns in how production items tend to appear together in daily transactions.

1. The 1-itemset analysis revealed that Plat C COM, Plat C Starcam, and Join Tuas Starcam had the highest frequency of occurrence in the transaction data. This indicates that these three products are essential components in the company's production process.
   This information is highly valuable in supporting decision-making related to warehouse operations and inventory management. Products with high support values, such as Plat C COM and Plat C Starca**m**, can be prioritized. In warehouse management, these frequently produced items should be placed near each other to speed up the picking process. From an inventory perspective, grouping products that often appear together can simplify storage and delivery processes, and assist in planning stock requirements more efficiently

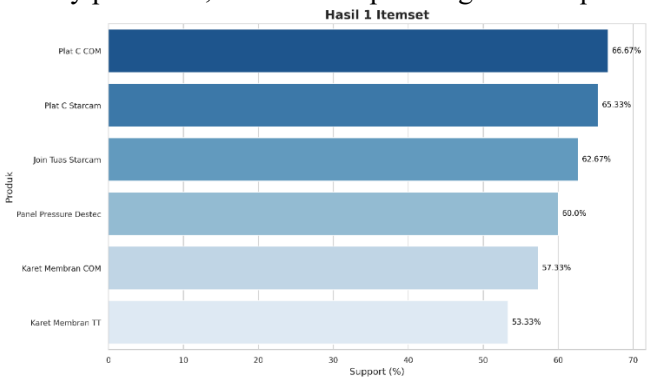

Figure 2. Result of 1-Itemset Analysis

2. The 2-itemset analysis identifies five strong product association patterns based on high confidence values. The highest confidence is found in the rule: "If Karet Membran COM is produced, then Plat C COM is also produced", with a confidence level of 81.4%. Other patterns also involve products such as Panel Pressure Destec, Plat C Starcam, and Karet Membran TT, indicating that these items are often produced together and have strong associative relationships within the production data.

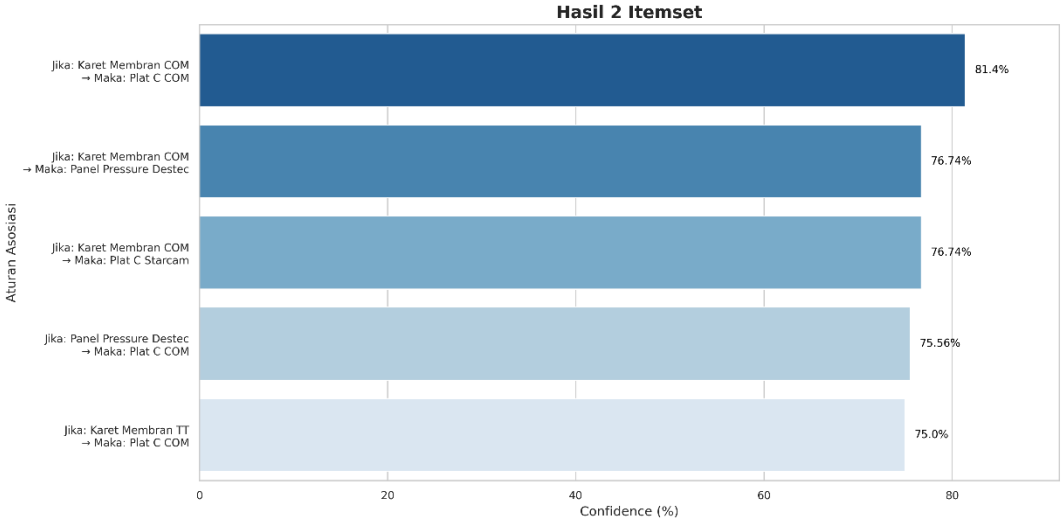

Figure 3. Result of 2-Itemset Analysis

This information is useful for supporting warehouse management and inventory control. It can be applied by grouping frequently co-occurring products (bundling), organizing stock placement together, and positioning related items close to each other in the warehouse to improve operational efficiency.

3. The 3-itemset analysis results show that all association rules have lift values ranging from 1.46 to 1.57, indicating that the products frequently appear together and are interrelated. A lift value greater than 1 suggests that the presence of one product increases the likelihood of the others appearing. The highest lift value, 1.57, was found in the combination of *Panel Pressure Destec*, *Plat C Starcam*, and *Karet Membran COM*, indicating that these three products are often used together in the production process.

   This information can be utilized in warehouse and inventory management, such as storing related products in close proximity, creating stock bundling packages, and organizing warehouse layouts to speed up and streamline the product retrieval process.

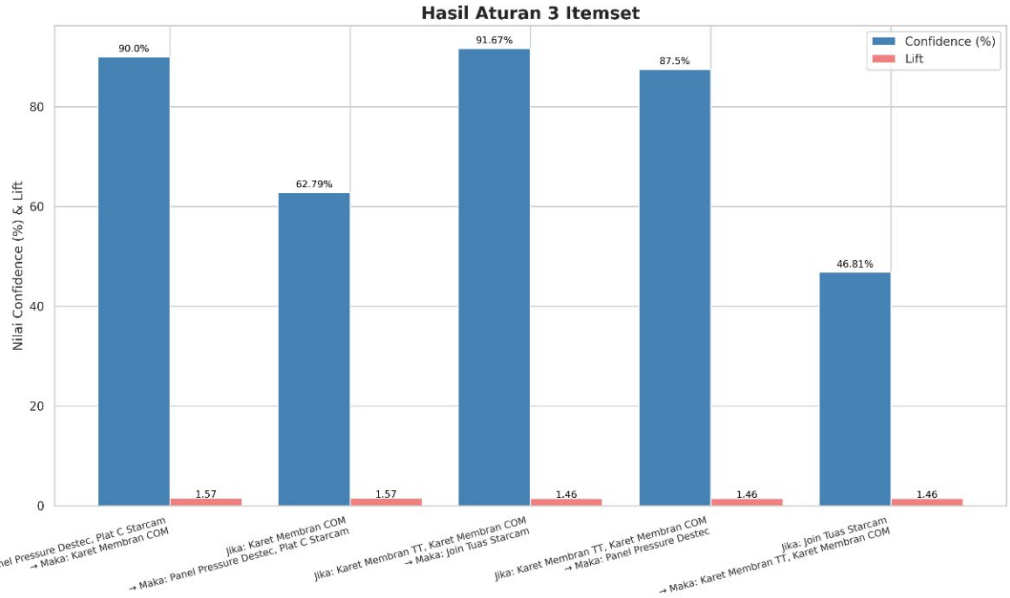

Figure 4. Result of 3-Itemset Analysis

4. The results of the 4-itemset association analysis show that all rules have high lift values, ranging from 1.85 to 1.98. A lift value greater than 1 indicates that the products are used together and have a strong relationship within a single production transaction. The highest lift value (1.98) was found in two rules, particularly the combination of Karet Membran TT, Karet Membran COM, and Plat C Starcam → Panel Pressure Destec. This high lift value suggests that these four products are strongly related and frequently appear together in production activities.

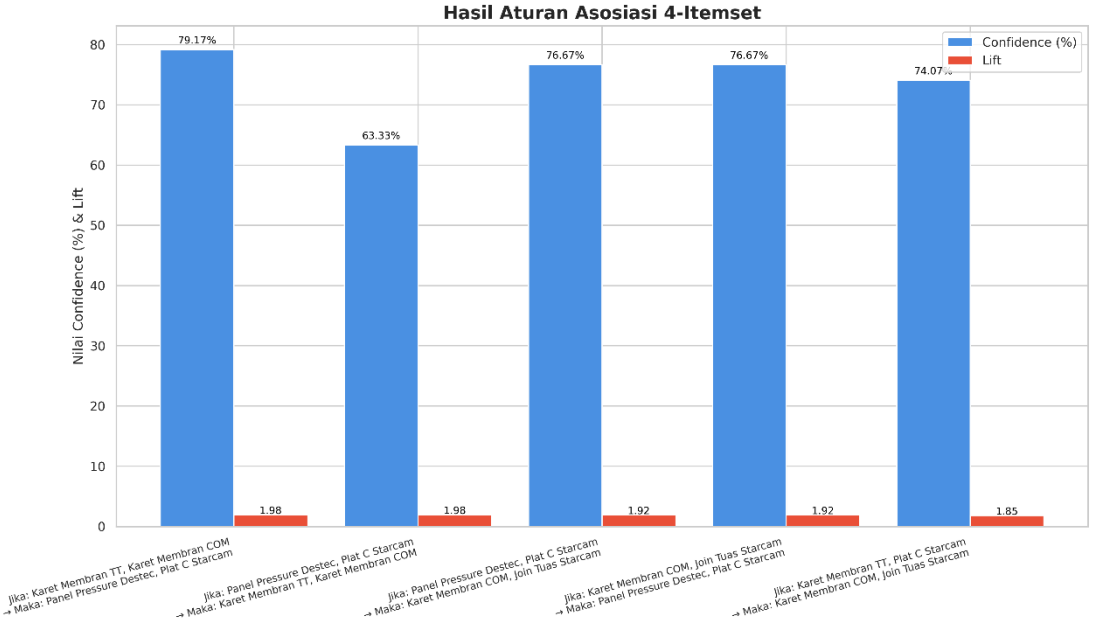

Figure 5. Result of 4-Itemset Analysis

In terms of warehouse management and inventory control, this information can be used to store related products in close proximity, organize stock packages that support one another, and design warehouse layouts that enable faster and more efficient product retrieval.

5. The results of the 5-itemset association analysis show that all rules have lift values above 2, indicating a very strong relationship between the products. The highest lift value of 2.25 was found in two rules involving the combination of Karet Membran TT, Panel Pressure Destec, and Plat C Starcam, which frequently co-occur with Karet Membran COM and Join Tuas Starcam. This indicates that these five products are consistently associated and often produced together as part of a recurring production pattern.

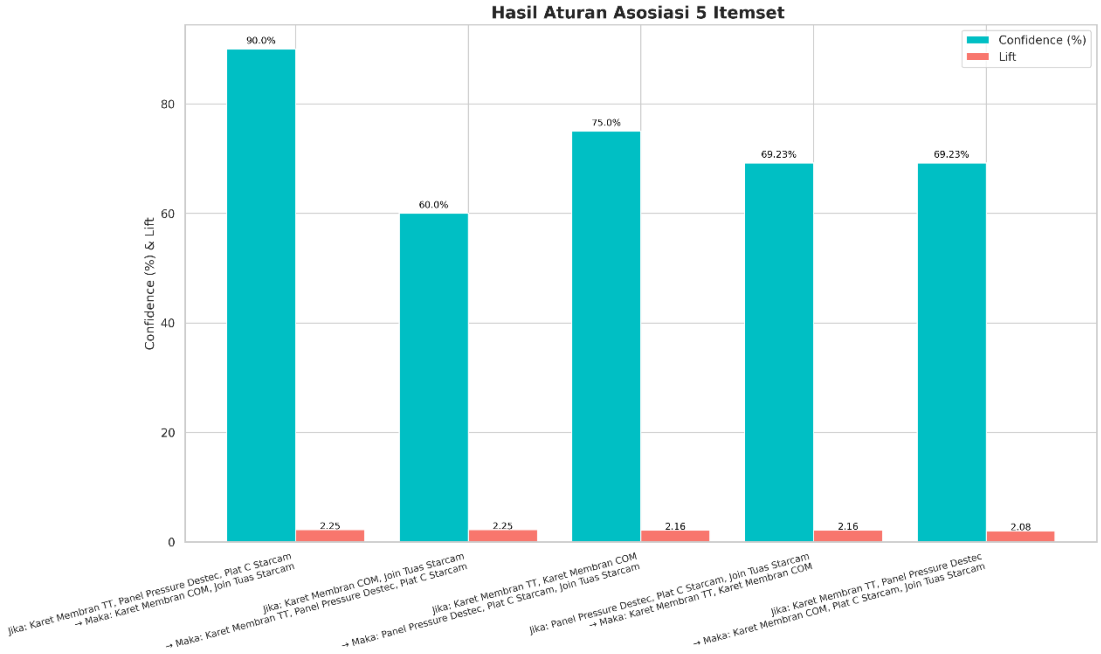

Figure 6. Result of 5-Itemset Analysis

In applying the results of this analysis, the strong relationships between products can serve as a foundation for decision-making in warehouse management and inventory control. These insights can be used to group related products in storage, design stock bundling strategies, and organize the warehouse layout to improve operational efficiency and create a more structured workflow.

4 Conclusion

Based on the analysis of production transaction data over a three-month period using the Apriori algorithm, several key findings were obtained. First, strong association patterns were identified between products. For example, the rule stating that if *Karet Membran TT*, *Panel Pressure Destec*, and *Plat C Starcam* are produced, then *Join Tuas Starcam* and *Karet Membran COM* are also likely to be produced, has a confidence value of 90% and a lift of 2.25. This indicates a strong relationship among these products within a single transaction. Second, all association rules generated have lift values greater than 1, which confirms that the product relationships are not coincidental but are based on real patterns in production activity. Lastly, the discovered patterns can be used to support better decision-making in warehouse management, product storage arrangement, inventory control, and even in designing production bundling strategies.

5 Suggestion

To improve this research and make it more useful in the future, several suggestions can be made. First, this study only used production data from three months, so the patterns found may not fully reflect the company's long-term production habits. Future research should consider using data from a longer period to get more accurate and complete results. Second, the association rules discovered in this study should be tested directly in inventory or warehouse management activities to check if they are truly useful in real situations. Third, this research focused only on building the analysis model using support, confidence, and lift, without developing any supporting tools. Future studies are recommended to build user-friendly applications, such as websites or dashboards, so that the analysis results can be easier to understand and use in daily business decision-making. Finally, future research should follow the latest updates on how the Apriori algorithm is used in production data analysis, and apply the newest methods to get better and more relevant results.

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