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Analysis of Drug Sales Patterns in the Belawan Naval Hospital Pharmacy using the Apriori Algorithm

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ABSTRACT

Hospital pharmacy plays an important role in ensuring drug availability and effective stock management. With the increasing number of drug redemptions, manual data management becomes inefficient and can lead to understocking or overstocking. Therefore, a method is needed that is able to automatically analyze drug sales patterns to improve stock management efficiency. One approach that can be used is the Apriori algorithm, an effective data mining technique for finding patterns in drug redemptions. This study aims to analyze drug redemption patterns at the Belawan Navy Hospital Pharmacy using the Apriori algorithm. The data used is drug redemption data. The Apriori algorithm is applied to find relationships between drug items that are often purchased together, so that it can provide useful insights in drug stock management. The results of the study showed that the Apriori algorithm successfully identified several significant drug redemption patterns. These patterns can be used to improve the efficiency of drug stock management and ensure timely drug availability, as well as reduce the risk of understocking or overstocking. The results of the study used logistic regression to predict discrete (binary) values from a column based on values from other columns and the accuracy obtained was 1.0 or 100%. This study concludes that the application of data mining with the Apriori algorithm can provide significant benefits in optimizing the management of drug stock redemption in hospital pharmacies.

Keywords: Apriori algorithm; Drugs; Data Mining; Pharmacy; Logistic Regression

1. INTRODUCTION

The Belawan Naval Hospital pharmacy is a vital part of the health care system in the region. As a provider of drugs and pharmaceutical products to military and civilian patients, these pharmacies have an important role in ensuring adequate drug availability and efficient stock management. In the hospital pharmacy environment, drug stock management is a key aspect that affects the availability of drugs for patients. Meeting and improving customer needs is essential because it has a major impact on the number of sales and customer satisfaction levels (Turukay et al. 2023). It is very sad if the transaction data is just stored and left alone, even though we can get information from that data (Wibowo and Karyati 2021).

With the development of information technology, the use of data management systems has become increasingly important to support efficiency in the management of drug stocks and pharmaceutical products. Data mining is becoming an increasingly popular tool for business information management. It is expected to produce a knowledge structure that helps decision-making (Prasetya et al. 2021). Data mining is the use and collection of data to find patterns or relationships in large data sets (Dongga et al. 2023). However, there are several different definitions for data mining, one of which is the process of finding patterns in very large data sets stored in storage using pattern recognition techniques, statistical techniques, and mathematical techniques (Saputra and Sibarani 2020).

A priori is one of the best data mining algorithms for analyzing drug sales patterns because it looks for patterns of relationships between different items in a dataset (Darmawan et al. 2022). A priori algorithm combines different types of association rules in data mining (Darmawan 2019). The A priori algorithm has been shown to be successful in previous research in finding patterns of item combinations from various sales transactions to identify customer interests, and is used to find association rules between items in a dataset (Panjaitan, Putri, and Muthia 2020).

In general, Machine learning is a discipline that studies statistical models and algorithms used by computer systems to perform specific tasks without written instructions. Machine learning algorithms generate mathematical models from sample data to derive these patterns and inferences (Rozi Kesuma Dinata and Novia Hasdyna, 2020).

Based on the research of tri mukti Wibowo, et al (2021), this study uses a priori algorithm to analyze sales

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transaction patterns at the Kanaya Rooftop Garden Store, an online store that sells animal supplies. The data analyzed consisted of 740 transactions and 117 types of products that occurred during April, May, and June 2021. The data was processed using Tanagra software with a minimum support of 0.02 and a minimum confidence of 0.35. This analysis found fifteen rules of association with different values of support and trust. According to the rule with the highest support value, buying a "1 ml needle onamed" is often followed by buying an "oral kepromec". The rule with the highest confidence value indicates that the purchase of "intracox oral 10ml" is often followed by the purchase of "interflox oral 10ml" (Wibowo and Karyati, 2021).

Then Saputra et al (2020), the study used a priori algorithm to analyze drug sales patterns. The results show that the Apriori Algorithm is effective in identifying the most frequently sold drugs, which can be a reference for future drug orders (Saputra and Sibarani, 2020).

Maharani et al (2024), this study produced a system that can analyze sales data of beauty products found in Underprice Skincare stores. The data processed using a priori algorithm and in this study is sales data at Underprice Skincare stores from November 1, 2023 to December 31, 2023. The resulting system can display product sales patterns at the Underprice Skincare store. The system can display the best-selling products based on the dataset that has been selected. The system in this study was built using the Python programming language (Maharani and Putri 2024).

To support this research, machine learning is used in the form of simple Python program code in its calculation with the tool used is a notebook jupyter. This study aims to analyze drug sales patterns in the Belawan Naval Hospital Pharmacy using a priori algorithm and analyze and apply Python and Machine Learning to process data. By utilizing this data mining technique, it is hoped that drug sales patterns can be identified that can provide a better understanding of patients' drug needs and help in decision-making related to drug stock management. Through this research, it is hoped that it can contribute to improving the efficiency of drug stock management in the Belawan Naval Hospital Pharmacy and provide a deeper understanding of drug consumption patterns in the military hospital environment.

2. LITERATURE REVIEW

Data mining is also known as knowledge discovery, knowledge extraction, data or pattern analysis, information gathering, etc. The purpose of data mining is to find valuable information. Data mining tools can answer a variety of complex questions once patterns and information have been discovered. In addition, data mining generates appropriate and relevant knowledge from the analyzed data. For example, hospitals have a significant amount of data, such as medical records (Saputra and Sibarani 2020). Data mining is the process of extracting valuable knowledge from a large and complex set of data (Dinata and Hasdyna, 2020). Data mining has many benefits and can provide significant added value for various industries and organizations (Gede et al. 2024).

The process of converting raw data into useful data is called Knowledge Discovery In Database (KDD). KDD is a structured analytical process that aims to obtain new and correct information, find patterns in complex and useful data (Komariyah et al. 2023).

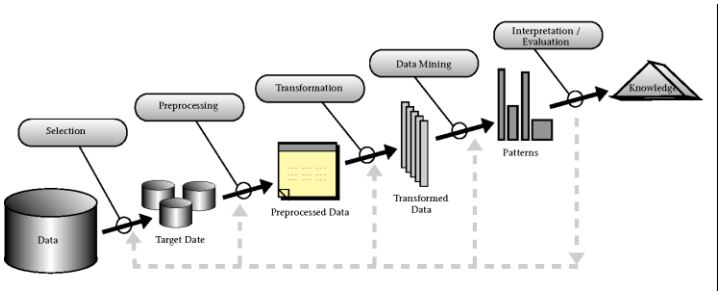

Fig.1 Knowledge Discovery Process in Databases
Source : (Abdullah 2024)

In the figure, several stages are explained such as data selection and understanding, data transformation, model formation (data mining), model evaluation, and the use of the knowledge found.

A priori algorithm looks for relationship patterns between multiple items in a dataset (Darmawan et al. 2022). A priori algorithm combines different types of association rules in data mining (Darmawan 2019). One of them is Association rules, which is a way of data mining to get associative rules between combinations of items (Sapitri et al.

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2022). Using this algorithm, relationship rules between items in the dataset can be found. This can help the decision-making process in data management. According to (Panjaitan, Putri, and Muthia 2020) In previous research, a priori algorithms have been shown to be successful in identifying customer interest by combining item patterns from various sales transactions.

Machine learning, also known as machine learning, is a field that studies statistical models and algorithms used by computer systems to perform specific tasks without written instructions (Dinata and Hasdyna, 2020).

Association rules or collections of items that frequently appear together in data can be used to find hidden relationships of interest in large data sets. For example, the {bread, butter} -> {milk} rule with a support value of 40% and a confidence of 50%, "Consumers who buy bread and butter have a 50% chance of also buying milk." This rule is considered important because it covers 40% of the total existing transaction records (Sulianta et al,2024).

High-frequency pattern analysis is one of the important techniques in data mining used to find patterns that frequently appear in data. The concurrent occurrence of multiple items is quite often referred to as an association between multiple items in a dataset (Aisyah et al. 2023). A supporting value is the percentage of an item or combination of items that exist in the database. The supporting values can be obtained by using the following formula:

1. High-frequency pattern analysis
   The support *value* of an *item* is formulated in the equation:

$$Support\ (A) = \frac{\sum Transaksi\ Mengandung\ A}{\sum Total\ Transaksi} X100\% \quad (1)$$

   The support *values* of the 2 *items* are formulated in the equation:

$$Support\ (B \cup A) = \frac{\sum Transaksi\ Mengandung\ item\ A\ dan\ B}{\sum Total\ Transaksi} X100\% \quad (2)$$

2. Association Rule Formation: After all the high-frequency patterns are found, the association rules A → B and A → B → C are calculated to find the association rules that meet the minimum trust requirements. The *confidence value* of rule A → B is obtained from the equation:

$$Confidence = P\ (B|A) = \frac{\sum Transaksi\ Mengandung\ item\ A\ dan\ B}{\sum Transaksi\ Mengandung\ Item\ A} X100\% \quad (3)$$

Python, the most popular programming language today, was created by Guido van Rossum and released in 1991. Python can be used for rapid prototyping or off-the-shelf software development because it can be used alongside software to create workflows, connect to database systems, read and modify files, handle big data and perform complex math (Ma'arif, 2020).

3. METHOD

This research was carried out quantitatively with numerical data and emphasized objective measurement of results. To demonstrate this, statistical analysis is also used. A priori algorithm method was used in this study to identify drug redemption patterns with a total of 1511 drug data. The following is an example of a research framework.

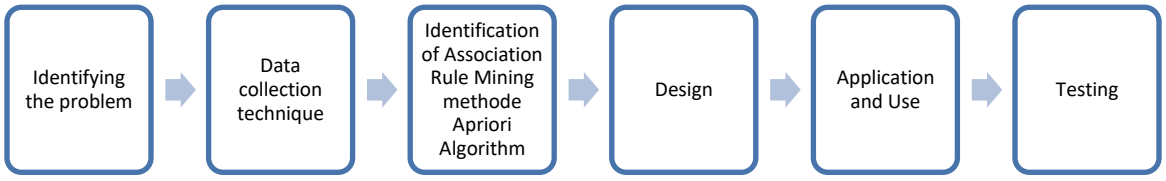

Fig.2 Research Outline

Identifying a problem, which is the process of recognizing or determining a condition, circumstance, or issue that requires research, analysis, or solution is known as problem identification.

Data collection techniques, . In this case, interviews were conducted face-to-face with several parties at the hospital, including the Head of the Hospital, the Head of the Pharmacy Office, and the Pharmacy Staff. Meanwhile,

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surveys are used to collect representative data from a specific population or sample. The survey was conducted after the interview to confirm whether the study was acceptable to the hospital and to collect data related to drugs and transactions.

Identify the association rule mining method a priori algorithm, the data mining method used to find the rules of a combination of items. High-frequency pattern analysis (frequent pattern mining) is an association analysis stage that attracts the attention of many researchers to produce efficient algorithms.

The design, planning process or arrangement of structures, patterns, or plans necessary to achieve a specific goal. In this case, the design of the process performed is the one depicted in the flowchart. The following is an example of a flowchart used in the study.

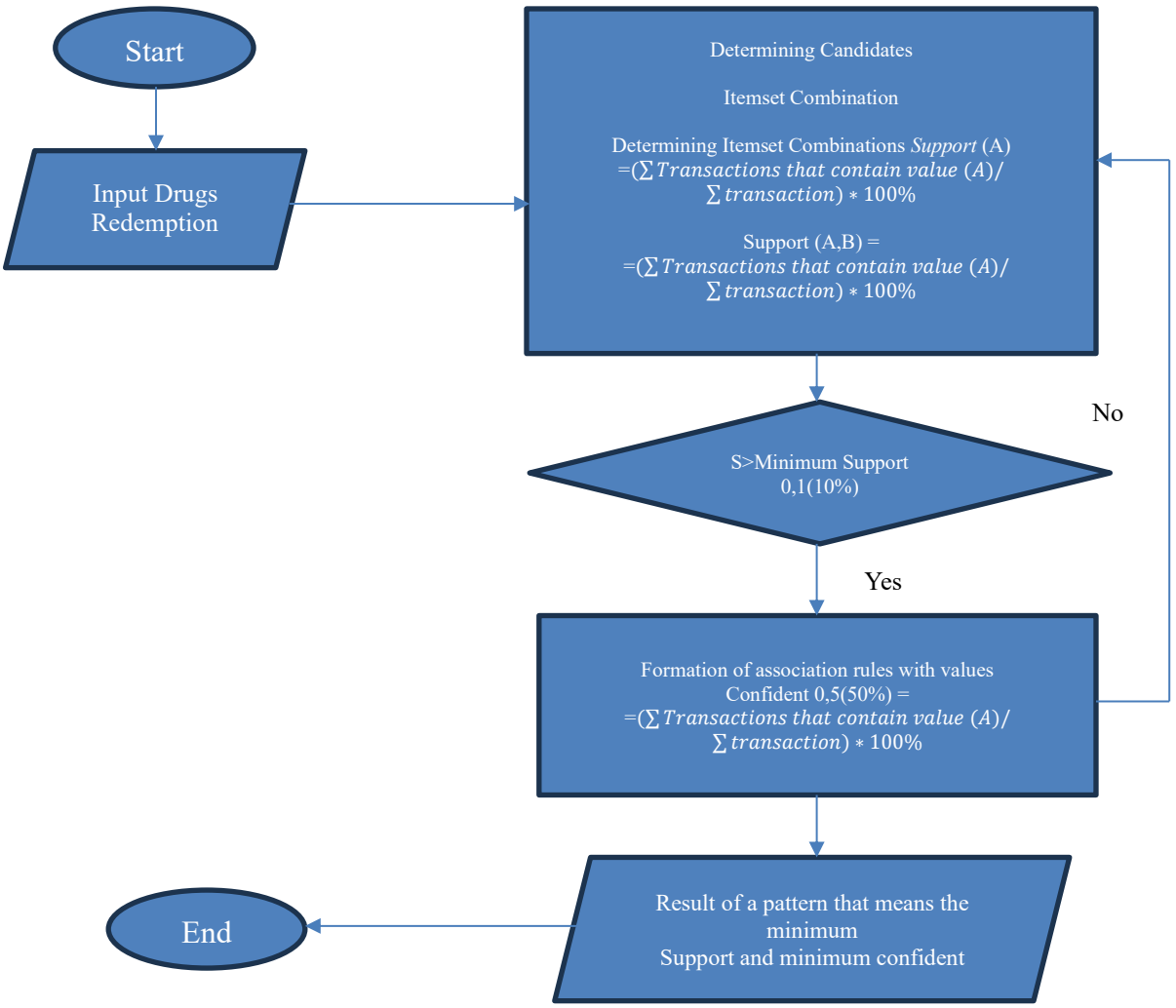

Fig.3 Research Flowchart

Application and use, For its implementation, the system design that has been made on several previous systems has been changed.

Testing, The process of evaluating or examining a product, system, or process to ensure that they operate in accordance with established specifications or meet specific standards.

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4. RESULT

In this chapter, the results of the analysis of drug redemption patterns with BPJS at the Belawan Naval Hospital Pharmacy will be discussed using a priori algorithm and machine learning techniques. This discussion aims to explain how drug sales data is processed and interpreted in order to find association rules that are useful for drug stock management. A priori algorithms are used to analyze transaction data to identify relationships between items that often appear together in drug redemptions. This analysis is expected to help the Belawan Naval Hospital Pharmacy in optimizing the management of drug stocks so that it can meet the needs of patients more efficiently. The study will also discuss the evaluation of the application of machine learning as an addition to data analysis, as well as its implications for overall pharmaceutical management.

The dataset used in this study is data on drug redemption transactions with BPJS from the Belawan Naval Hospital Pharmacy. This data includes transactions that occurred between August and September 2024, which include various types of drugs redeemed at the pharmacy.

Table 1.
Drug Sales Data for the Period August - September 2024

No.	Date	Drug Name	Sum
0	9/18/2024	Amoxcilin	1.0
1	9/21/2024	Cefadroxil	3.0
2	9/21/2024	Interistin	1.0
3	9/21/2024	Ikadyn	1.0
4	9/21/2024	Ponstan	2.0
…	…	…	…
1510	9/21/2024	Cataflam 50 mg	2.0
1511	9/21/2024	Ponstan	2.0
1512	9/21/2024	Original Honey	1.0

The following data is data that has been cleaned or has been cleaned from data that is not needed when the data processing process is carried out. The distribution of the data can also be seen from the following figure:

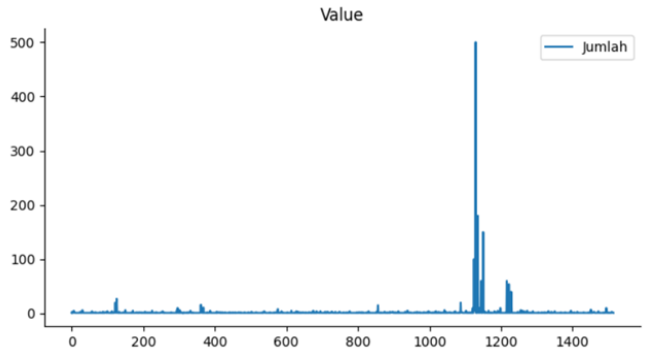

Fig.4 Dataset Distribution Diagram

In this priori algorithm calculation, we will explain the results of the application of the Apriori algorithm to analyze drug redemption data with BPJS at the Belawan Naval Hospital Pharmacy. A priori algorithms are used to identify association rules, or rules for purchasing drugs, which will serve as a benchmark to determine which drugs are most frequently sought after and redeemed by consumers. This can make it easier for the Belawan Naval Hospital Pharmacy to use it to make decisions such as planning stock. The following steps are taken to create a data mining model using a priori algorithm:

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1. Specify the data you want to process.
2. Determine the minimum support, minimum confidence, and minimum lift values
3. Drafting the rules of the associations formed.

In this process, the application of the Apriori algorithm begins with several important parameters, namely:

A. Minimum support: 0.01 (1%) – i.e. the rule will only be obtained if a set of items appears in at least 1% of the total transactions.
B. Minimum confidence: 0.3 (30%) – i.e. the rule is only considered significant if the conditioned item has a 30% chance of appearing together.
C. Minimum lift: Determines the minimum lift threshold. Only rules with a minimum lift of >1 will be considered.

Where the data to be processed is the drug redemption data contained in Table 4.1. to find support data from the data. The trick is to divide the number of items redeemed by the number of all redemption processes.

$$support\ (\text{Paracetamol}) = \frac{12}{30} = 0{,}04(40\%)$$

The number 12 can be interpreted as the number of redemptions in Paracetamol, while 30 is the amount of redemption of paracetamol from the entire redemption process based on the data contained in Table 1. To find confidence data from this data, the method is to divide the number of redeemed items along with the number of redemptions from the first item

$$Confident(Paracetamol - Imodium = \frac{4}{12}\ \text{x}\ 100\% = 33{,}3\%$$

The number 4 above can be interpreted as many items redeemed at the same time, for example Paracetamol and Imodium. And the 12 below can be interpreted as the number of redemption processes on Paracetamol dosage items. The values of the Association Rule for drug redemption at the Belawan Naval Hospital Pharmacy are as follows after using the calculation process on the redeemed product data:

Table 2.
Association Rules for the Sale of Drugs

It	Rules	Support	Confidence	Elevator
1	['Amoxcilin'] -> ['Omeprazole']	10.00%	60.00%	4.50
2	['Omeprazole'] -> ['Amoxcilin']	10.00%	75.00%	4.50
3	['Amoxcilin'] -> ['Sanmol']	10.00%	60.00%	2.25
4	['Sanmol'] -> ['Amoxcilin']	10.00%	37.50%	2.25
5	['Antangin'] -> ['Sanmol Syr']	10.00%	75.00%	4.50
6	['Sanmol Syr'] -> ['Antangin']	10.00%	60.00%	4.50
7	['Betadine'] -> ['Decolgen']	10.00%	100.00%	10.00
8	['Decolgen'] -> ['Betadine']	10.00%	100.00%	10.00
9	['Promag'] -> ['Bodrex']	10.00%	60.00%	3.60
10	['Bodrex'] -> ['Promag']	10.00%	60.00%	3.60
11	['Cefixime'] -> ['Sanmol']	10.00%	75.00%	2.81
12	['Sanmol'] -> ['Cefixime']	10.00%	37.50%	2.81
13	['Imodium'] -> ['Cendo Xitrol']	10.00%	50.00%	2.50
14	['Cendo Xitrol'] -> ['Imodium']	10.00%	50.00%	2.50
15	['Entrostop'] -> ['Imodium']	10.00%	60.00%	3.00
16	['Imodium'] -> ['Entrostop']	10.00%	50.00%	3.00
17	['Entrostop'] -> ['Paracetamol']	10.00%	60.00%	1.50
18	['Imodium'] -> ['Paracetamol']	13.33%	66.67%	1.67

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19	['Paracetamol'] -> ['Imodium']	13.33%	33.33%	1.67
20	['Sanmol'] -> ['Omeprazole']	10.00%	37.50%	2.81
21	['Omeprazole'] -> ['Sanmol']	10.00%	75.00%	2.81
22	['Blue Panadol'] -> ['Paracetamol']	10.00%	100.00%	2.50
23	['Red Panadol'] -> ['Sanmol']	10.00%	75.00%	2.81
24	['Sanmol'] -> ['Red Panadol']	10.00%	37.50%	2.81
25	['Paramex'] -> ['Paracetamol']	13.33%	66.67%	1.67
26	['Paracetamol'] -> ['Paramex']	13.33%	33.33%	1.67
27	['Ranitidine'] -> ['Paracetamol']	10.00%	75.00%	1.88
28	['Sanmol Syr'] -> ['Voltadex']	10.00%	80.00%	1.88
29	['Voltadex'] -> ['Sanmol Syr']	13.33%	80.00%	4.80
30	['Simvastatin'] -> ['Vitacimin']	10.00%	75.00%	4.50
31	['Vitacimin'] -> ['Simvastatin']	10.00%	60.00%	4.50
32	['Sanmol', 'Amoxcilin'] -> ['Omeprazole']	10.00%	100.00%	7.50
33	['Amoxcilin', 'Omeprazole'] -> ['Sanmol']	10.00%	100.00%	3.75
34	['Sanmol', 'Omeprazole'] -> ['Amoxcilin']	10.00%	100.00%	6.00
35	['Amoxcilin'] -> ['Sanmol', 'Omeprazole']	10.00%	60.00%	6.00
36	['Sanmol'] -> ['Amoxcilin', 'Omeprazole']	10.00%	37.50%	3.75
37	['Omeprazole'] -> ['Sanmol', 'Amoxcilin']	10.00%	75.00%	7.50

From Table 2. It can be analyzed as follows:

Rule 1: The drug **'Amoxicillin'** is redeemed at the same time as **'Omeprazole'**, and the confidence rate reaches 60%. (*Confidence*: 60%, *Lift*: 4.50)

Rule 2: The drug **'Omeprazole'** is redeemed at the same time as **'Amoxicillin'**, and the confidence rate reaches 75%. (*Confidence*: 75%, *Lift*: 4.50)

Rule 3: The drug **'Amoxicillin'** is redeemed at the same time as **'Sanmol'**, and the confidence level reaches 60%. (*Confidence*: 60%, *Lift*: 2.25)

Rule 4: The drug **'Sanmol'** is redeemed at the same time as **'Amoxicillin'**, and the confidence level reaches 37.5%. (*Confidence*: 37.5%, *Lift*: 2.25)

Rule 5: The drug **'Antangin'** is redeemed at the same time as **'Sanmol Syr'**, and its confidence level reaches 75%. (*Confidence*: 75%, *Lift*: 4.50)

…

Rule 37: The drug **'Omeprazole'** is redeemed at the same time as the combination **of 'Sanmol'** and **'Amoxicillin'**, and the confidence rate reaches 75%. (*Confidence*: 75%, *Lift*: 7.50)

Furthermore, the graph of the results of the confidence and support values is as follows:

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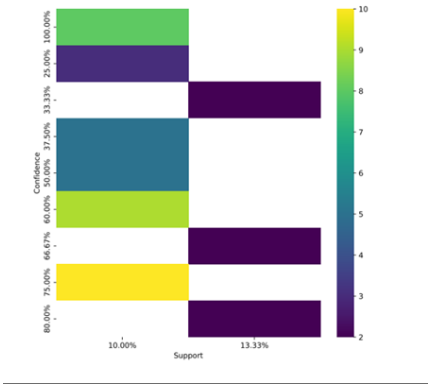

Fig.5 Comparison Matrix between Confidence and Support

If shown in detail, the graph of support and confidence values can be seen from Figure 4.3 and Figure 4.4 as follows:

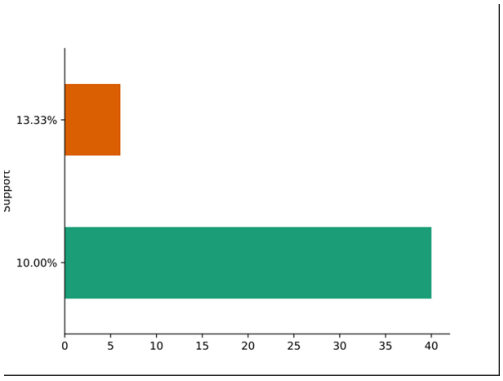

Fig.6 Value Graph of Support

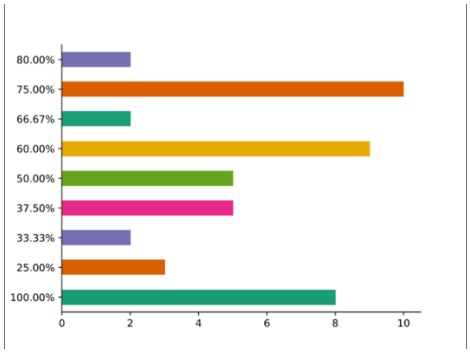

Fig.7 Value Graph of Confidence

Once the pattern is found using a priori algorithm, predictions can be made using machine learning models. In this study, machine learning will be used, which is Logistic Regression. Logistic Regression is used to predict the discrete (binary) value of a column based on the value of other columns. In this case, the previously processed data can be used to predict the outcome of the new data based on other features. Logistic Regression is an algorithm suitable for binary classification, and in this case, the model is trained on existing data to predict discrete target classes. The

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accuracy of the model is evaluated with metrics such as accuracy score, which in the example above reaches 100%, indicating that the model is able to predict the results very well on the test data.

The accuracy results will be printed using print(accuracy). In the results shown, the accuracy of the model reaches 1.0 (100%), which means the model correctly predicts all the data. Association analysis such as a priori and machine learning prediction models such as Logistic Regression complement each other in data analysis. A priori can provide initial insight into the relationships between items or features in the data, while Logistic Regression can be used to make more accurate predictions about new data based on patterns that have been studied. For example, if pharmaceutical association data shows that certain drugs are often redeemed together, Logistic Regression can be used to predict whether the new redemption process may include a combination of similar items, allowing providers to perform better stock planning and more personalized product recommendations.

DISCUSSIONS

This study successfully identified drug redemption patterns at the Belawan Navy Hospital Pharmacy using the Apriori algorithm, which showed a significant relationship between drug products that were frequently redeemed simultaneously. These results are in line with previous studies that also applied the Apriori algorithm to analyze product sales patterns in other sectors, but with a different focus, namely on drug inventory management in the hospital environment. The implications of these findings are very important, especially in the context of drug stock management in hospitals, where drugs with high redemption frequencies can be prioritized to remain available, while drugs that are rarely redeemed can be reduced in stock. However, this study has limitations in terms of the scale of the data and the time period analyzed, which may affect the generalizability of the results. Further studies with broader data and longer time periods will provide a more comprehensive picture of drug consumption patterns. In addition, the application of machine learning with logistic regression that achieved 100% accuracy shows great potential in predicting drug redemptions in the future, which can support more precise decision making in drug stock planning and more efficient pharmaceutical product promotion.

5. CONCLUSION

In conclusion, the application of the a priori algorithm has proven effective in identifying patterns of relationships between different drug products often redeemed simultaneously at the Belawan Naval Hospital Pharmacy. This allows for better understanding of how products relate, enabling pharmacy management to optimize stock levels by ensuring high-frequency items remain available while reducing rarely redeemed items to prevent overstocking. The 100% accuracy achieved in this analysis, implemented using Python and machine learning, provides valuable insights into patient purchasing patterns, both for BPJS and non-BPJS patients, aiding in decisions related to stock adjustments, promotions, and drug recommendations.

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