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Analysis and System Design at Mitra Sejati Hospital for Patient Drug Administration using Data Mining and Apriori Algorithm

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Abstract

This research focuses on system analysis and design at Mitra Sejati Hospital to increase the efficiency of administering medicines to patients. In this effort, data mining approaches and Apriori algorithms were implemented to identify significant treatment patterns and facilitate better decision making in medication administration management. This research is aimed at finding out how to analyze data on drug administration to patients at Mitra Sejati Hospital. The research methodology includes the system requirements analysis stage, collecting patient treatment data, and identifying treatment patterns using data mining techniques. The Apriori algorithm is used to extract association rules that represent the relationship between drugs given to patients. Next, system design was carried out to integrate the analysis results into the drug administration process at Mitra Sejati Hospital. The research results show that the application of data mining and the Apriori algorithm can help identify critical treatment patterns, reduce the risk of drug interactions, and increase the efficiency of the drug administration process. The proposed system is able to provide more precise drug recommendations based on the patient's medication history. By combining data mining technology and the Apriori algorithm in the drug administration system, Mitra Sejati Hospital can optimize patient medication management, improve the quality of health services, and reduce the potential risk of errors in medication. This research contributes to the development of intelligent and innovative health information systems in the hospital environment.

Keywords: *Data Mining, Apriori, Mitra Sejati Hospital.*

1. Introduction

Technological improvement in the current era is a process in increasing added value to its users which provides so many benefits in various advances in social aspects. The use of technology used by various parties to help complete work is a must in life. Humans as technology users must be able to take advantage of developing technology, especially utilizing applied technology in the business world which of course provides many benefits to the ease of work so that effectiveness and accuracy in information delivery can be created.

The hospital is a place for further treatment of local community health as well as referrals from other places, with services and the provision of drugs according to the disease suffered. The disease suffered will be immediately treated by paramedics by administering medicine. To find out the pattern of drug data provided and anticipate the supply of drugs in the Pharmacy department of Mitra Sejati Hospital so as not to experience delays in drug availability, which of course will have an impact on patients who are suffering from diseases and patients receiving treatment.

In general, each patient has different disease and drug tendencies. Different drugs are given for different diseases, but sometimes the same drug is given to different diseases taking into account the similarity of the symptoms experienced by the patient. This depends on the results of the diagnosis of the disease and the prescription of drugs given

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by the doctor. Therefore, this research will be required to find solutions in meeting the supply of drugs in hospitals.

One of the strategies that can be done in solving the problem of drug supply in hospitals is to find associations from the use of drugs needed by following the pattern of drug use that often occurs in order to make it easier to determine and manage drug stocks before drug stocks in hospitals run out. In Computer Science or Statistical Science, it is known as a way to find out the pattern of giving drugs to patients at Mitra Sejati Hospital. This science is Data Mining, where data mining is a field of science that teaches about processing large amounts of data with the aim of finding useful information from the data so that the accumulated data can be useful. Data mining is the process of searching for patterns or interesting information in selected data using certain techniques or methods. The techniques, methods, or algorithms in data mining vary widely. The selection of the right method or algorithm depends largely on the overall purpose and process of Knowledge Discovery in Database (KDD).

A priori algorithm is an *Association Rule* method in data mining to determine frequent itemsets that function to help find patterns in data (*frequent pattern mining*) [1]. This a priori method is a way to measure the proximity data between the food drugs provided. A priori algorithms are used to find *association rules* that meet the limits of *support* and *confidence* values. A priori works by analyzing a collection of items purchased at the same time on several drug uses. counter to a set of data patterns that appear in a database through several iterations or loops [2].

2. Research Methodology

2.1. Data mining

Data mining is a process of mining or discovering new information that is carried out by looking for a certain pattern or rule from a number of data that accumulates and is said to be big data. Data mining can also be interpreted as a series of processes in finding or exploring the added value of a data in the form of knowledge that has not been known manually that knowledge can be useful. Data mining is a form of implementation that is applied to find a model and pattern that is able to make predictions on data based on previous data in a certain period of time [3].

2.2. Knowledge Discovery in Databases (KDD)

In the *data mining process* which is usually called *the Knowledge Discovery Database (KDD). Knowledge Discovery Databases (KDD)* is the application of scientific methods to *data mining*. Knowledge Management (KM) is an action to create business value and generate competitive advantages in a company. The company's goal in implementing KM is to keep this knowledge from disappearing and can be shared with other employees in the company. KM is divided into three levels, namely *Document Management (level 1), Information creation, sharing and management (level 2), and Enterprise intelligence (level 3).* In this explanation, *data mining* is one step of the KDD process, there are several processes as seen in the figure below [4].

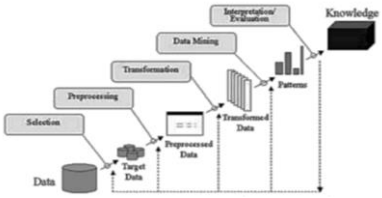


Figure 1. *Knowledge Discovery Database Process*
(Source : http://erlinaindra.blog.binusian.org/2014/06/10/data-mining-dan-aplikasi-untuk-knowledge-management/)

2.3. Assosiation Rule

Association analysis is also known as one of the *data mining* techniques that is the basis of various *other data mining* techniques". In particular, one of the stages of association analysis that has attracted the attention of many researchers to produce efficient algorithms is frequent pattern mining [5]-[9]. The basic methodology of association analysis is divided into two, namely:

2.3.1. High Frequency Pattern Analysis

This stage looks for the minimum qualified combination of *items from the support* value in the *database*. The support *value* of an *item* is obtained by the following formula [10]-[13]:

$$Support\ A = \frac{Jumlah\ Transaksi\ (A)}{Transaksi}\ x\ 100\% \quad (1)$$

Where:

Support A : Supporting Value for item A
Number of Transactions (A) : Transaction Amount for item A
Transaction : Total Transactions of all available items

Meanwhile, the support values of the two items are obtained from the following formula:

$$Support\ (A,B) = P(A \rightarrow B) = \frac{Jumlah\ Transaksi\ (A \rightarrow B)}{Transaksi}\ x\ 100\% \quad (2)$$

Where:

Support (A,B) : Supporting Values for items A and B simultaneously
Number of Transactions (A->B) : Transaction Amount for item A then B
Transaction : Total Transactions of all available items
P(A->B) : Permutation for item A then B

2.3.2. Establishment of Associative Rules

Once all the high-frequency patterns have been found, the associative rules that meet the minimum requirements for *Confidence* are searched by calculating *the associative* rule *Confidence* $A \rightarrow B$.

The Confidence *value* of the A→B rule is obtained from the following formula:

Confidence of associative rules A →B. The value of rule A →B is obtained by the formula [14]-[15]:

$$Confidence\ (A,B) = P(A \rightarrow B) = \frac{Jumlah\ Transaksi\ (A \rightarrow B)}{Transaksi\ A}\ x\ 100\% \quad (3)$$

Where:

Confidence (A,B) : Value *Confidence* for items A and B at the same time
Number of Transactions (A->B) : Transaction Amount for item A then B
Transaction A : Total Transactions of all items A
P(A->B) : Permutation for item A then B

2.4. Method

Research Method is a scientific process or method of obtaining data that will be used to solve problems by conducting direct field studies to collect data. The stages carried out in the research in order to solve the problems that have been described in the previous stages, including the background of the problem, include:

1. Data Collection Techniques

The data collection technique is in the form of a statement about the nature, circumstances, certain activities and the like. Data collection in this study was carried out at Mitra Sejati General Hospital which is related to the pattern of giving drugs to patients using the following 2 methods, which is the description used:

a. Interview
b. Observation

2. *Library Research*

Literature Studies is one of the elements that supports as a theoretical basis for researchers to examine the problems discussed. In this case, the researcher uses several literature sources including: Books, National Journals, International Journals and other sources related to the field of Data Mining science.

3. Results and Discussion

3.1. Application of a priori algorithm

In applying the priori method, Drug Use Data is needed and the data is then processed according to the stages of the priori algorithm. System Algorithms are the steps taken by a system in processing and solving a problem.

Data identification is carried out after the data is collected and in accordance with the needs of the system. Therefore, to produce conclusions based on *rules* in data analysis, it is necessary to use drug use data that has been carried out. The data analysis is carried out based on association rule techniques using a priori algorithm with several iterations or steps.

3.1.1. Flowchart Algoritma *Apriori*

The following are the stages of applying the Apriori algorithm, which are as follows:

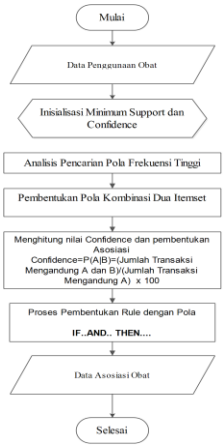


Figure 2. A priori algorithm flowchart

3.1.2. High Frequency Pattern Search Analysis

The frequency value is calculated based on 100 drug use data and then a search for *the support value* is carried out with the formula:

$$Support\ (A) = \frac{Jumlah\ Transaksi\ Mengandung\ A}{Total\ Transaksi}\ x\ 100\% \quad (4)$$

The support of an itemset in a transactional dataset is the proportion of transactions in the data that contains the itemset. In the context of a priori, support is a measure of how often an itemset appears in a dataset in a transactional data. In the Aries algorithm, support is used as a treshold or threshold to determine whether or not an itemset is worthy of being considered a frequently occurring itemset. Itemsets that have support above the specified threshold will be considered candidate itemsets to be used in finding relevant association rules. Looking for candidates for 1 itemset with *the following support* values:

3.1.3. Formation of the Combination Pattern of Two Itemsets

The formation of a 2-itemset frequency pattern is formed from *drug items* that meet *the Minimum Support*, namely by combining all *items* into all 2-itemset combination patterns, then the Confidence value *of each item will be calculated based on the formula.*

$$Confidence = P(A|B) = \frac{Jumlah\ Transaksi\ Mengandung\ A\ dan\ B}{Jumlah\ Transaksi\ Mengandung\ A}\ x\ 100 \quad (5)$$

In the context of a priori algorithms, "*Confidence*" refers to one of the important metrics used to evaluate how strong the associations between items in an association rule are. The concept of *Confidence* is closely related to support and lift, all of which are metrics used in association analysis. *Confidence* is a measure of how often a rule is found to be true, when item A appears, item B also appears. It is expressed as the proportion of the number of transactions containing both items A and B to the number of transactions that contain only item A. Confidence indicates how often item B appears in transactions that also have item A.

3.1.4. Calculating *Confidence*

The results of the calculation with *the Confidence value* are obtained with the following *calculation sample*:

$$Confidence = P(A|B) = \frac{Jumlah\ Transaksi\ Mengandung\ A\ dan\ B}{Jumlah\ Transaksi\ Mengandung\ A}\ x\ 100$$

$$Confidence = P(\text{Coenzyme Q10}|\text{Ranitidine}) = \frac{17}{23}\ x\ 100 = 73.91\%$$

$$Confidence = P(\text{Vip albumin}|\text{Ranitidine}) = \frac{12}{22}\ x\ 100 = 54.55\%$$

$$Confidence = P(\text{Betason} - \text{N}|\text{Ranitidine}) = \frac{8}{18}\ x\ 100 = 44.44\%$$

$$Confidence = P(\text{Ranitidine}|\text{Coenzyme Q10}) = \frac{17}{41}\ x\ 100 = 41.46\%$$

$$Confidence = P(\text{Betason} - \text{N}|\text{Dulcolax supp}) = \frac{6}{18}\ x\ 100 = 33.33\%$$

3.1.5. Establishment of the If-Then Rule

From the steps that have been carried out above, the items that meet the minimum *Confidence* = 30% and can be concluded as follows:

a) If the patient is taking medication Coenzyme Q10 then the patient also needs medication Ranitidine (because conf = 73.91%)
b) If the patient uses the drug Vip albumin, then the patient also needs the drug Ranitidine one (because conf = 54.55%).
c) If the patient is taking Betason-N medication then the patient also needs the drug Ranitidine (because conf = 44.44%).
d) If the patient is taking the drug Ranitidine then the patient also needs the drug Coenzyme Q10 (because conf = 41.46%).
e) If the patient is taking Betason-N medication then the patient also needs the drug Dulcolax supp (because conf = 33.33%).

3.1.6. Formation of conclusions

From the results of the formation of the rules above, it can be concluded that if the patient needs Betason-N drugs, then it is likely that they will also need the types of Ranitidine and Dulcolax supp drugs, then if the patient uses Coenzyme Q10 drugs, Ranitidine drugs will also be recommended.

3.2. System Implementation

In achieving the implementation objectives, the main focus is to implement the pre-prepared system design. This process involves the selection of the right hardware and software to support the simulation of the application of patient medication administration at Mitra Sejati Hospital Medan using a priori algorithm. Hardware must be carefully selected to run algorithms efficiently, optimize drug delivery processes, and meet the overall system needs. On the software side, the selection of the appropriate operating system, database, and application software will play a crucial role in the successful implementation.

3.3. Test Results

This chapter aims to provide an in-depth understanding of what the results of the application that has been developed will look like. The focus is on a detailed explanation of the various displays contained in the Application of the Apriori Algorithm in a web-based patient medication application, with Mitra Sejati Hospital Medan as a case study. The reader will be guided through each display that appears on the program, providing a clear overview of the user interface and its functionality.

3.3.1. Interface Display

At the system interface design stage, the main focus is to develop a layout that reflects the needs and functions of the system by distinguishing several key pages. The home page will be the starting point that provides key information and efficient navigation. Login and registration pages are designed to facilitate user access to the system, while dashboards provide a brief overview and visualization of relevant data. The user profile page gives the user control to manage their personal information. The existence of a search page allows users to find information quickly, while a detail page provides complete details regarding a particular entity or data. Through this layout design, it is hoped that the system interface can provide an intuitive and efficient user experience.

a) Main Menu Page

The main menu is the initial display when *the user* enters the system. This page contains an overview of data mining applications for Mitra Sejati Hospital Medan.

Figure 3. *Main Menu* Form

b) Drug Data Detail Form

The Drug Data Detail Form is used by *the user*. In *this Drug Data Detail* Form, *users* can see information from each drug.

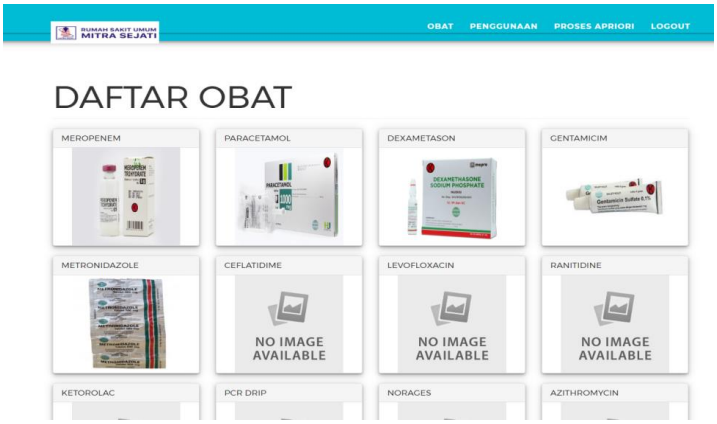


Figure 4. *Drug Data Display* Form

c) Form Login Admin

This design part is equipped with a login page design. *The Login* Page is used exclusively for *web* admins who can access Product *Forms*, Transaction Forms.

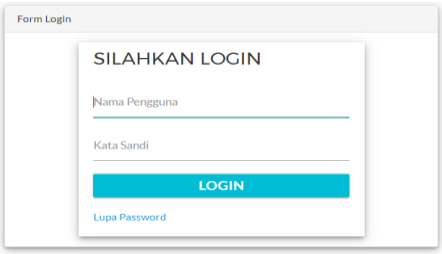


Figure 5. *Admin* Login Form

d) Admin Page

The Admin Menu design was created to design a web page design form that will be used by the admin to go to the Drug *Form*, *a priori Process* Form and *Drug Use* Form.

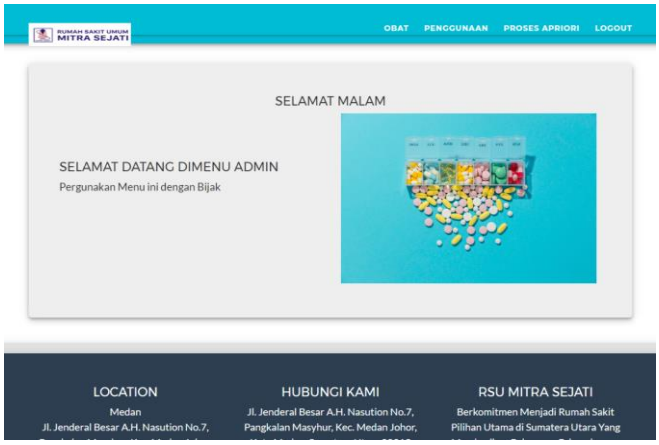


Figure 6. *Admin Page* Form

e) Drug Type Management Form

The Drug Form is used to view existing Drugs in *the database*, delete Drugs, add Drugs and change Drugs. Here is the design for the Drug *Form* page.

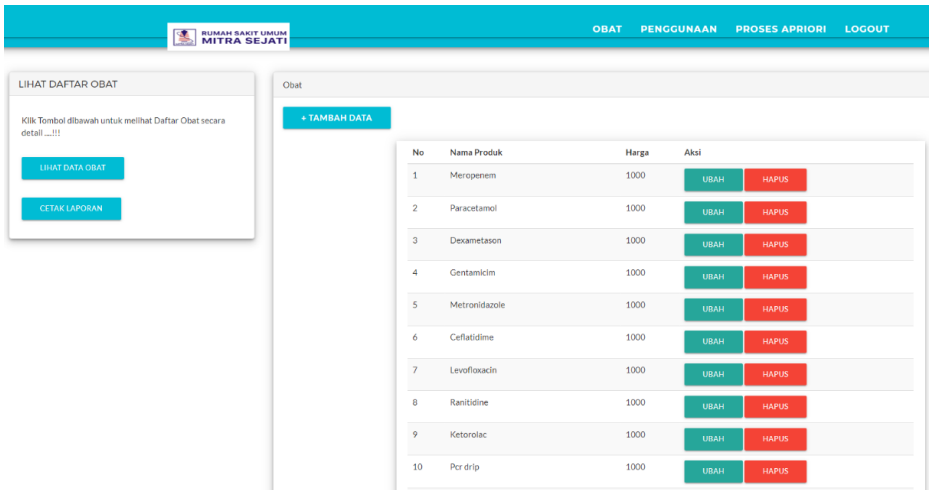


Figure 7. *Manage Product Type* Form

f) Usage Data Management Form

The drug use form is used to view drug use data in the *database*, delete drug use data, add drug use data and change drug use data. Here is the design for *the* drug use form page.

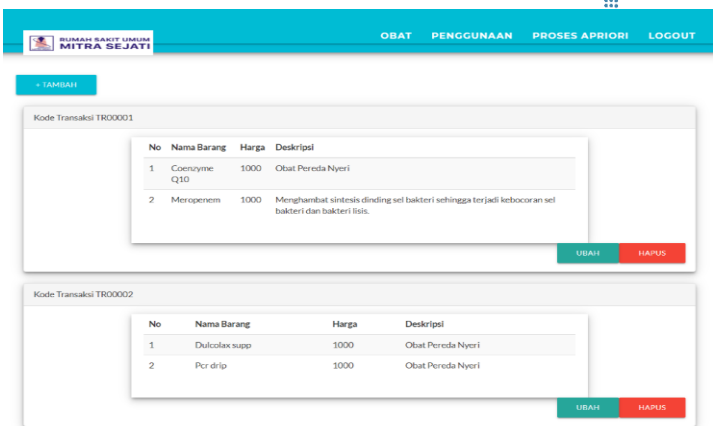


Figure 8. *Drug Use Management* Form

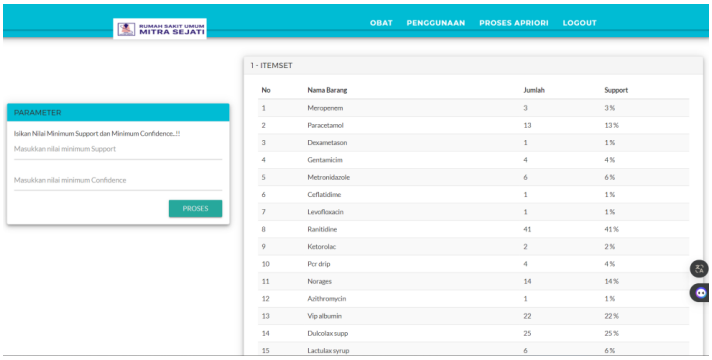


Figure 9. A *priori process* form

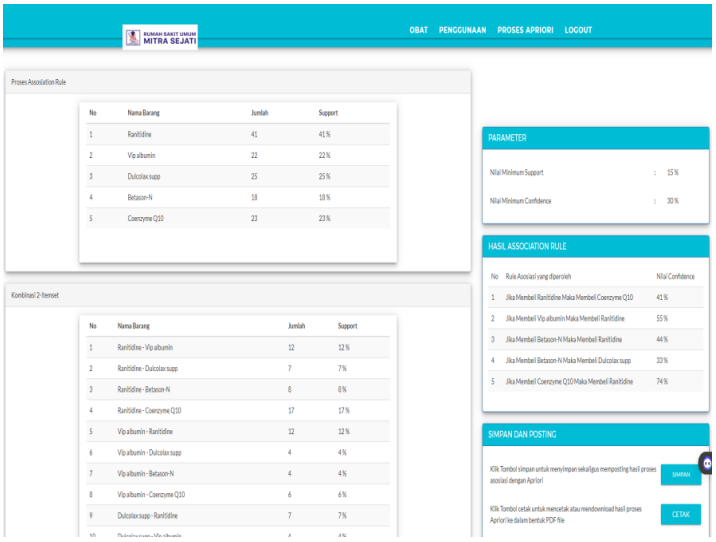


Figure 10. A *priori process result* form

3.3.2. System Testing

Testing is carried out by means of *whitebox* and *blackbox* testing where *whitebox* testing is a test that has several techniques in conducting software testing, namely, *loop testing* which focuses on testing the validation of the structure of a loop, *data flow testing* which looks at how data moves in a program, *control flow testing* which uses the

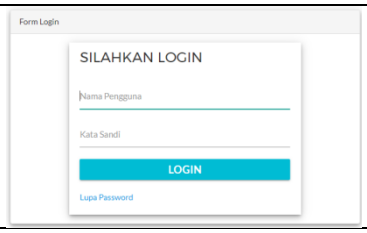
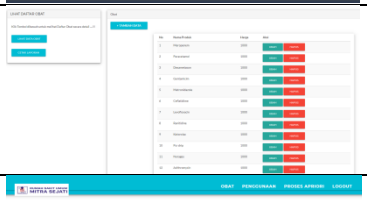
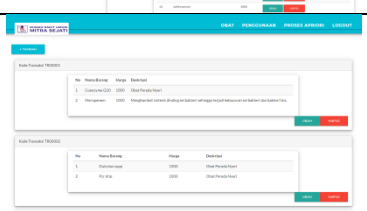
program's control flow as a model in reference to create *test cases*, branch testing which focuses on branching tests in a program, and *base-path testing* which is a technique that will test all statements or statements at least once, meanwhile, *blackbox* testing is a software testing method that tests the functionality of an application as opposed to its internal structure or work. Specific knowledge of the application code/internal structure and general programming knowledge is not required. The following is a *whitebox* test of the app that has been designed.

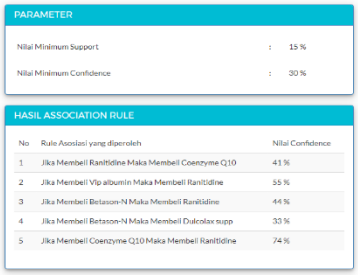
Table 1. *Whitebox* Test *Route Data*

No	Route	Information
1	http://localhost/apriorimitrasejati/index.php	Redirect to Homepage
2	apriorimitrasejati/home.php?content=login	Login Page
3	A priorimitrasejati/home.php?content=home	Displaying the admin page after logging in
4	A priorimitrasejati/home.php?content=goods	View drug data
5	A priorimitrasejati/home.php?content=view	View data page
6	/home.php?content=Usage	Displaying drug use data
7	/home.php?content=proses	A priori process
8	home.php?content=detailbarang&id=2	Displaying detailed drug data

The following is a blackbox test in each form that has been designed.

Table 2. *Blackbox Testing* Admin

No	Test Name	*Test Case*	Test Results
1	Login Page (*Login*)		The system will process *the username* and *password*, if it is appropriate then the main menu will appear, and if not then the message "*Login* Failed" will appear
2	Dasboard Admin		After successfully logging in, the system will display an admin page where this admin page will be used to manage data on the system including disease data, symptoms and knowledge base
3	Displaying Drug Data Page		After the admin clicks on the system drug menu, a display of the drug table that has been saved into the system can appear
4	Usage Page (Save, Change, Delete)		The usage data page can run fine. Usage data can change according to the condition of the selected button and can be displayed on the *web page*
5	View Process Page		After the admin clicks the priori menu, the system will display drug data with 1 itemset

No	Test Name	*Test Case*	Test Results
6	Results Page		The results page can run well after the user enters support and *Confidence data*.

4. Conclusion

Based on the analysis of the problems that occurred in the case raised in the problem analysis in analyzing the data on the administration of drugs to patients at Mitra Sejati Hospital, the analysis and design of the system at Mitra Sejati Hospital for the provision of patient drugs using data mining and a priori algorithm is a strategic step in optimizing the drug management process in the hospital. Through the analysis, the need for the system has been identified, and data mining was chosen as an approach to uncover hidden patterns in patient drug data. A priori algorithms, which are applied, allow for efficient identification of associations between drugs, providing a foundation for better decision-making in drug administration. This system is expected to improve efficiency and safety in the drug management process, as well as provide a holistic view of patient treatment patterns. In designing a system application that adopts the Apriori algorithm for administering drugs to patients at Mitra Sejati Hospital, it can be done by using UML modelling and coding using the PHP programming language. The designed system testing can run well and can help Mitra Sejati Hospital, judging from the indicators of easy and simple system use.

To improve the capabilities and functions of this program, there are several suggestions that can be given for development that this application can be updated by adding the desired itemset, so you don't have to analyze only 2 itemsets. The app can use other methods such as FP-Growth or combine several methods to make it even better. The system can be developed into a modern web model such as Laravel version 10.

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