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STOCK PREDICTION OF SINGLE-USE MEDICINE USING AUTOREGRESSIVE INTEGRATED MOVING AVERAGE

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Stock Prediction of Single-Use Medicine Using Autoregressive Integrated Moving Average the(3, 1, 3) model, derived from the (p,q,d) model where p is the AR level, d is the process level that makes the data stationary, and q is the MA level. The (3, 1, 3) model used provides quite good results the ARIMA (3, 1, 3) model can be a good tool to predict the need for consumable drug stocks show that the ARIMA (3, 1, 3) model gives good results,log likelihood values and information criteria indicating that the model is reliable. Predictions for the demand for consumable drugs in 2025 show a downward trend, Requires further attention to understand the causes. health centres can plan drug procurement more precisely and efficiently meet patient needs without experiencing overstocks or shortages.

Keywords: predictions, ARIMA, single-use medicine.

1. Introduction

Medicines that can only be used once or within a certain period of time and cannot be stored for further use are called consumable medicine. Consumable medicine are usually used at Banda Sakti Health Centre in Lhokseumawe City in primary health care, where they are given to patients for the treatment of certain diseases or immunisation purposes. The purpose of using these consumables is to reduce the risk of contamination or inappropriate storage of drugs as well as ensuring that patients receive the correct dose.

Single-use medicine play an important role in the health system,especially in preventing infections and improving patient safety. The importance of single-use medicine lies in their ability to improve patient safety, operational efficiency, and compliance with evolving health standards. The management of consumable medicine stocks has an important role that not only affects patient satisfaction and public confidence in the health services provided.The According to the Regulation of the Minister of Health of the Republic of Indonesia No.30 of 2022 concerning Guidelines for Drug Management, every health facility is obliged to carry out good drug management, including accurate planning of drug needs [1]. However, many hospitals and health centress still face difficulties in forecasting grug needs, which often leads to excess or shortage of supplies. Overstocks can result in a waste of resources, while shortages can cause delays in treatment, potentially worsening the patient's condition.

Prediction is the use of statistical techniques in the form of a future picture based on the processing of historical figures [2], the use of appropriate prediction methods can help Puskesmas managers plan and manage drug supplies more efficiently. One method commonly used in time series analysis is Autoregressive Moving Average (ARIMA) [3]. The ARIMA method has the

ability to analyse historical data patterns and provide accurate predictions for the coming period [4]With the application of this method, it is hoped that the management of consumable medicine stocks at the Banda Sakti Community Health Centre in Lhokseumawe City will be improved, so that health services to the community will be better.

The ARIMA method is a forecasting method developed by George Box and Gwilym Jenkins which is often called the Box-Jenkins time series method [5]. The ARIMA model is a combined method of the Autoregressive (AR) and Moving Average (MA) methods. ARIMA models have been widely used in various fields, including finance, economics, and health, to predict future trends and patterns. In the contect of medicine stock management, the ARIMA Method can be used to predict the demand for medicines based on historical data, thus enabling health centres to make informed decisions about stock management.

The management policy of consumable medicine in the pharmaceutical installation of Banda Sakti Health Centre is very strict. Records must be made of all medicines administered to patients and distributed to the PUSTU in each kampong, including the type of medicine, dosage, and date of administration and date of distribution. This is very important to monitor the effectiveness of treatment and ensure that medicine are not wasted. In addition, the health centre conducts regular evaluations of consumable drugs to improve health services and ensure that all patients receive the best care.

Banda sakti Health Centre also strives to increase community awareness about the importance of using the right medicine and according to their needs. Through health education programmes, the community is educated on the correct use of medicines, including knowledge of consumable drugs and the risks associated with inappropriate drug use. Therefore, is it expected that the community will use medicines more wisely, which in turn will improve overall health.

So far, Banda Sakti Health Centre in Lhokseumawe City still uses a manual method to predict the stock of consumable drugs by looking at previous data. Based on the data, the amount of consumable medicine stock that will be prepared is estimated manually. However, this approach is not always accurate because today's sales results are not necessarily the same as the following year's data. This method often leads to errrors in the provision of consumable drug stocks, which results in waste and triggers the occurrence of insufficient medicine stocks.

2. Methods

2.1 Time Series

Times series data is a type of data that is collected in accordance with the time sequence within a certain time span. The basic idea in time series is that the current observation (Zt) is influenced by one or more previous obseervations (Zt-k) (Wulandari R.A & Gernowo R, 2019). The type of data that consists of variables collected in is a new development in economic forecasting methods, does not aim to form a structural model (single equation or simultaneous equation) based on economic theory and logic, but by analysing probabilistic or stochastic time series data by holding the philosophy of 'let the data speak for themselves'.

The ARIMA (Autoregressive Integrated Moving Average) method is a method used for short-term forecasting. The use of the ARIMA method in short-term forecasting is very appropriate because the ARIMA method has very accurate accuracy. And also determines a good statistical relationship between the variables to be forecasted and the value used for forecasting. As for long-term forecasting, the forecasting accuracy is not good. Usually the forecasting value will tend to be constant for a fairly long period [6]. ARIMA uses past and present values of the

dependent variable to produce accurate short-term forecasts. ARIMA is suitable if the observations from the time series are statistically related to each other [7].

time order within a certain time span is also known as a time series. In the discrete case, the frequency can be for example seconds,minutes,hours,days,weeks,months or years and [8].

2.2 ARIMA (Autoregressive Integrated Moving Average)

The Autoregressive Moving Average (ARIMA) method or also referred to as the Box-Jenkins method is a method that was intensively developed by George Box and Gwilym Jenkins(1976), which is a new development in economic forecasting methods, does not aim to form a structural model (single equation or simultaneous equation) based on economic theory and logic, but by analysing probabilistic or stochastic time series data by holding the philosophy of 'let the data speak for themselves'.

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Examination of the plots of the autocorrelation function (ACF) and partial autocorrelation or commonly classed (PACF). The purpose of the ACF and PACF examination is to determine the configuration of the ARIMA model that is suitable for getting the number of autogressive processes (AR) to affect the time series variable data, the total moving average (MA) and the number of times the number to make the data stationary (d) is the purpose of the ACF and PACF examination [11].

ARIMA is a suitable forecasting method for non-stationary data. The ARIMA model is usually denoted by three parameters [12]. ARIMA (p,d,q), and the following is the general formula of ARIMA Autoregressive Moving Average:

$Xt = \mu + (1 + \emptyset 1\ )Xt{-}1 + \cdots + (\emptyset p - \emptyset p{-}1)Xt{-}p - \emptyset pXt{-}p{-}1 + et\ {-}\theta 1et{-}1{-}\cdots{-}\theta qet{-}q$

Description:

et = time error value at time t

Xtt = time series data at time t 19

μ = constant value

$\emptyset p$ = autoregressive parameter to p = 1,2,3, ..., n

θq = autoregressive parameter to q = 1,2,3, ..., n

2.3 Stationer Data

Stationary data refers to a state where time series data tends to fluctuate around an average value. When graphed against time, stationary data often crosses the horizontal axis. Generally, stationary data will show a horizontal pattern along the time axis. In other words, the time-

dependent variation revolves around a stable mean value, while the variance remains relatively constant [13]

2.4 Python

Python is an interpretive programming language that is known for being easy to learn and has a focus on code readability. In general, Python uses object-oriented, imperative and functional programming paradigms [14].

Python supports various programming paradigms, especially object-oriented, imperative, and functional programming, without any particular limitation. One of Python's features is that it is a dynamic programming language that comes with automatic memory management. Like other dynamic programming languages, Python is usually used as a script language, although in practice, its use is broader and includes contexts that are not usually done with script languages [15]

3. Research Methods

Quantitative research methods are used in this research, where numerical data is involved in the process of measuring and analysing the variables.

3.1 Techniques for Collecting Data

In this study the authors used the following techniques to collect data:

1. Sample Data

Sample data in this study in the form of information related to the study case is collected for research on consumable drug stock data and this data information will be used as input when the data is processed.

2. Observation

The Banda Sakti Health Centre of Lhokseumawe City was directly observed as part of the observation process for this research. In addition, an analysis of the problems encountered in monitoring the process of recapitulating consumable medicine stock data at the Banda Sakti Health Centre was carried out Lhokseumawe City. In addition, an evaluation of the needs of the current problems is also carried out to facilitate calculations.

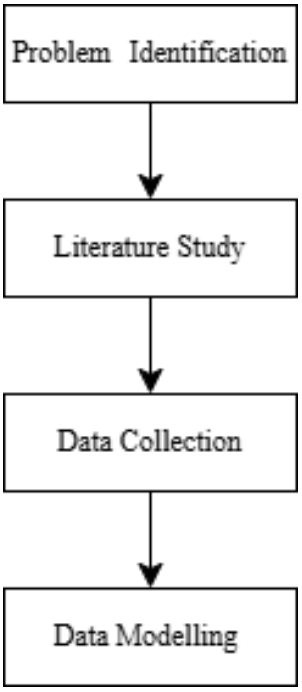
3. Interview

Furthermore, interviews were conducted with the Head of the pharmacy / drug warehouse of the Banda Sakti Health Centre, Lhokseumawe City and staff who had a hand in the process of recapitulating consumable drug stock data and determining the most needed drugs each year and interviewing these parties and asking what the obstacles were in the process of stocking consumable drug data so far. Puskesmas Banda Sakti Lhokseumawe City provides primary and secondary data for this research in the form of files.

4. Literacy Study

This research uses journals that have been reviewed by the author, books from official institutions and websites related to the research title as a reference source.

Table 1. Stages of research



3.1.1 Problem Identification

At this stage, a problem search is carried out, then continued by finding a solution to the problem that has been obtained. This research aims to implement the ARIMA method in forecasting consumable drug stocks.

3.1.2 Literature Study

Before being able to determine what contributions can be made by this research, it is necessary to find references from previous relevant research as well as several other objects such as books, internet, academics, and essays to get useful information in this research.

3.1.3 Data Collection

In order to collect the information required for the research, data collection is carried out. In this study, two data collection methods were used:

1. Primary Data Source

Primary data is obtained from interviews conducted with the staff of the Banda Sakti Health Centre, Lhokseumawe City.

2. Secondary Data Sources

Secondary data is obtained from books, internet, journals, which have relevance to the object of this research.

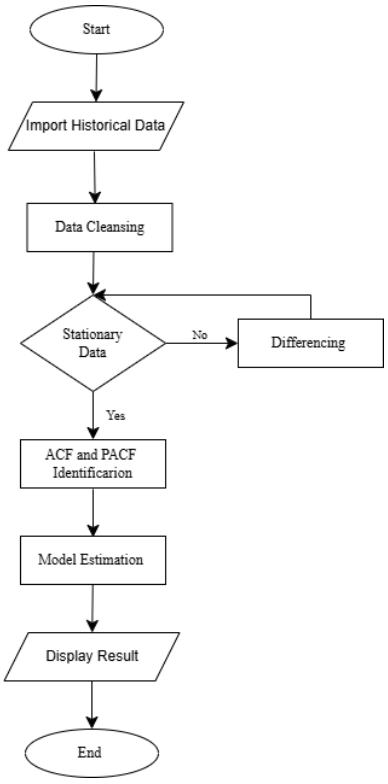
3.1.4 Data Modelling

At this stage, forecasting of consumable drug stocks is modelled using the ARIMA (Autoregressive Integrated Moving Average) method.

3.2 Schematic of the System

The schematic of the system for forecasting consumable medicine stocks at the Banda Sakti Health Centre in Lhokseumawe City is shown in the figure below :

Table 2. Schematic of the System



The following system flow description process will be explained through the following points:

1. Import Historical Data that will be used.
2. Perform Data Cleaning or Data Cleaning
3. Differencing will be performed if the data is not stationary.

4. Perform model estimation by selecting the most acceptable and suitable model type at this time.Next, select the model to be used provisionally and estimate its parameters.
5. Display the prediction results.

4. Problem Analysis

At Banda Sakti Health Centre in Lhokseumawe City, stock prediction of consumable drugs is an important challenge that must be faced to ensure adequate drug availability for patients. The fluctuating demand for drugs, influenced by various factors such as epidemics, seasonality, and health policies, makes stock management complex. Delays in drug procurement can have a direct impact on health services, potentially disrupting the treatment process and patient safety. Therefore, an effective method is needed to predict drug stock requirements, one of which is by using the Autoregressive Integrated Moving Average (ARIMA) model.

The ARIMA method offers a statistical approach that can help analyse historical drug usage data to identify patterns and trends. By applying this model, Banda Sakti Health Centre is expected to be able to obtain more accurate predictions of future consumable medicine stock requirements. However, challenges such as data limitations, sudden changes in demand patterns, and potential overfitting must be considered to keep the prediction results relevant and reliable. Therefore, collaboration between the health team and data analysis is essential to improve prediction accuracy and ensure efficient stock management.

5. Data Presentation

In the stage of data analysis of consumable drugs obtained by puskesmas banda sakti lhokseumawe city, the following are the top 5 data that the author obtained. then the following data presentation is as follows:

	NO	NAMA OBAT	Satuan	Sisa Stok Per 31 Des 2021	Pemakaian Rata Rata per bulan	Jumlah Kebutuhan Tahun	Rencana Kebutuhan Tahun	Harga	jumlah	Pengadaan Dana JKN	Jumlah2	Tahun
0	1	Antigen A-Glory	Kotak	0.0	0.40	7.20	7.20	201818	1453089.6	1.0	201818.0	2022
1	2	Antigen B-Glory	Kotak	0.0	0.40	7.20	7.20	181636	1307779.2	1.0	181636.0	2022
2	3	Antigen D-Glory	Kotak	0.0	0.40	7.20	7.20	201818	1453089.6	1.0	201818.0	2022
3	4	Aquadest	Botol	0.0	1.00	18.00	18.00	62370	1122660.0	NaN	0.0	2022
4	5	Asam Asetat 6% 1 Liter	Botol	0.0	0.11	1.98	1.98	132000	261360.0	NaN	0.0	2022

Figure 1 Data Presentation

This table contains data on the supply of consumable drugs at Banda Sakti Health Centre, covering various important aspects of drug management.

The table shows the remaining stock of drugs from January 2021, providing an overview of the current inventory. This information is important to know whether the stock of drugs is sufficient or if immediate procurement is needed.

The table also displays the average usage data per month, which is used to calculate the annual requirement. With this information, the health centre can plan its drug requirements for the coming year. The annual needs plan is also included, showing the target number of drugs to be

fulfilled. Drug prices and quantities required are also recorded, making it easier to calculate the total cost of procurement.

The table includes information on the source of procurement funds, which is the JKN Fund. By knowing the source of funds and the amount available, the health centre can plan drug procurement more precisely. The quantity and year data shows the number of drugs ordered and the year of procurement, which helps in tracking the history of drug procurement.

5.1 The Number of Years of Need Over Time

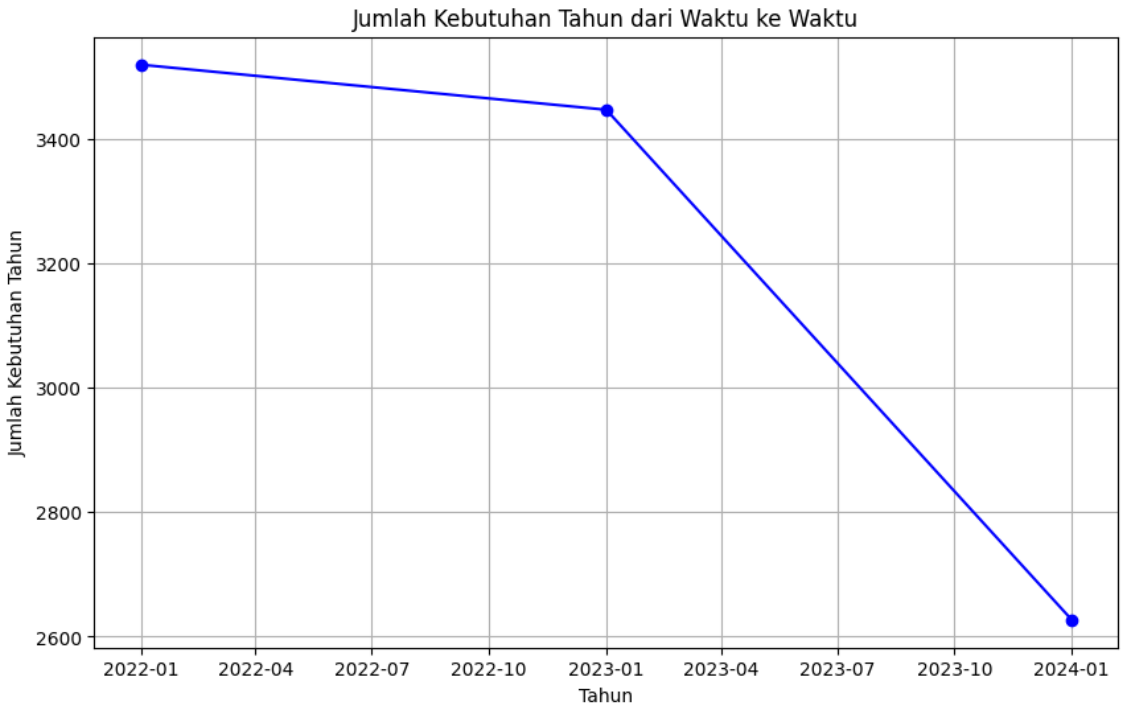


Fig 2 Total Demand per Year

This figure shows the trend of the number of demand years over time. The horizontal axis shows years, while the vertical axis shows the number of years demanded. The blue line shows the number of years demanded each year.

It can be seen that the number of demand years is decreasing year by year. In 2022-01, the number of demand years was around 3500. Then, there is a decrease in 2023-01, where the number of demand years is around 3450. Finally, there is a significant decrease in 2024-01, where the number of year requirements is around 2600.

The decrease in the number of demand years is likely due to various factors, such as changes in health policies, changes in people's lifestyles, and increased effectiveness of disease prevention programmes. To find out the exact cause of this decline, further analysis is required.

5.2 Total Demand per Year

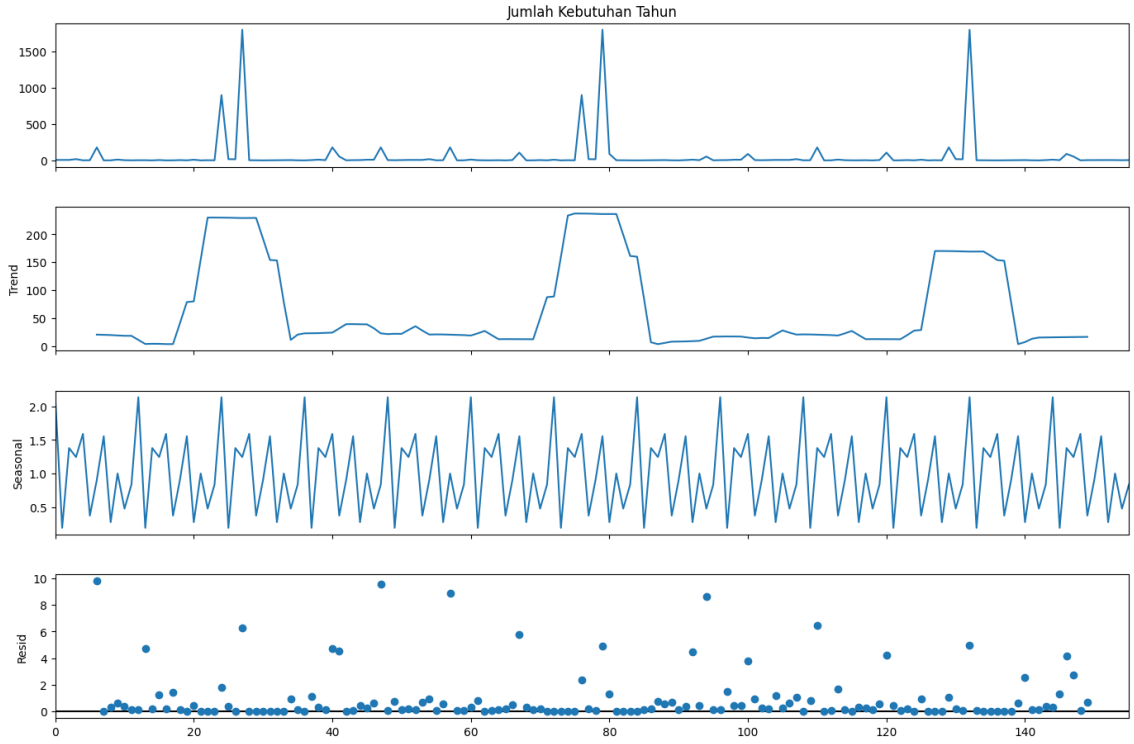


Fig 3 Total Demand per Year

The figure shows the data decomposition to predict the need for consumable drugs at Banda Sakti Health Centre, Lhokseumawe City. Data decomposition is the process of separating time series data into its components, namely trend, seasonality, and residual.

The trend component shows the general trend of the data over time. In the figure, the trend component shows that the demand for consumable drugs at Banda Sakti Health Centre tends to rise and fall periodically. This may be due to factors such as seasonality, health campaigns, and an increase or decrease in the number of patients.

The seasonal component shows a recurring pattern in the data that occurs within a certain period of time. In the figure, the seasonal component shows that the demand for consumable drugs tends to increase at certain periods of the year. This may be due to factors such as disease seasons, public holidays, and certain health events.

The residual component is the remainder of the data after the trend and seasonal components have been removed. The residual component reflects the random variation in the data. In the figure, the residual component shows that the random variation in the consumable drug demand tends to be small. This indicates that the data decomposition model is able to explain most of the variation in the data.

Based on the data decomposition, it can be concluded that the demand for consumable drugs at Banda Sakti Health Centre is influenced by trend, seasonal, and residual factors. By understanding these components, prediction of consumable drug needs can be done more accurately. Accurate predictions are essential to ensure that Banda Sakti Health Centre always has sufficient drug supplies to meet patient needs.

5.3 Autocorrelation plot

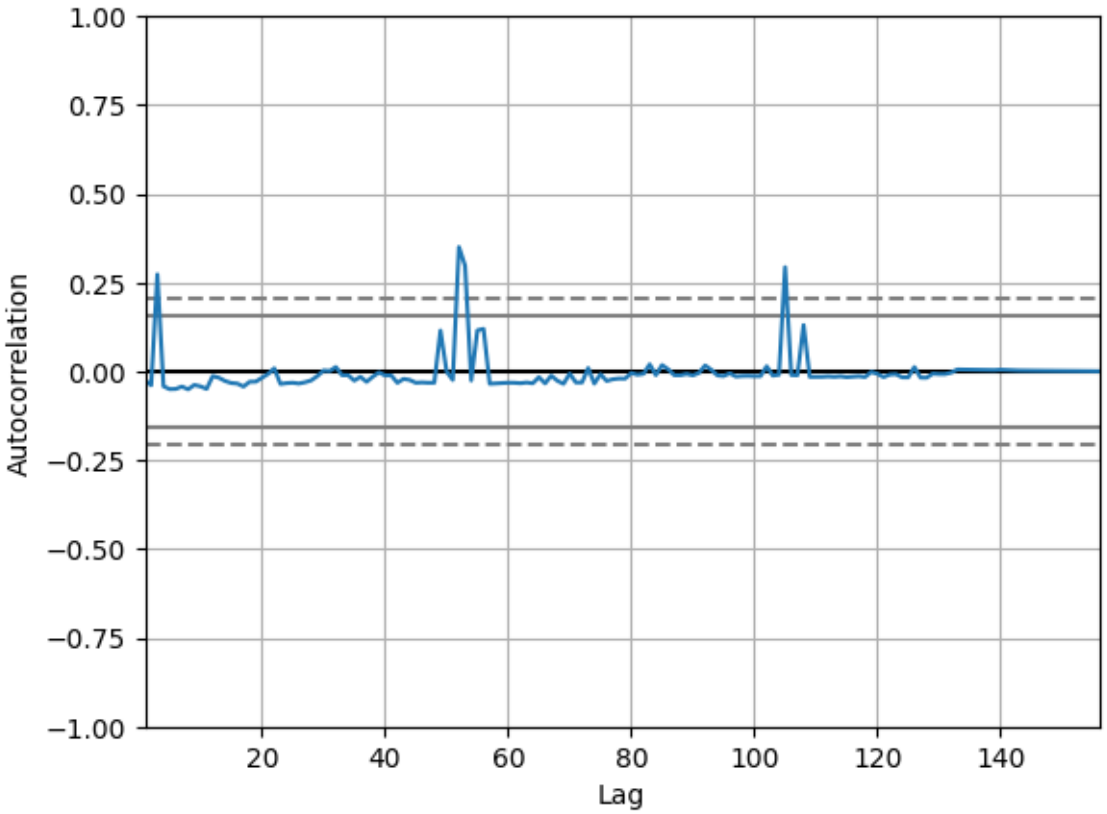


Fig 4 Autocorrelation plot

The figure shows an autocorrelation plot, which is a statistical tool used to measure the correlation of a time series with itself at various time lags. This plot shows that the data has significant autocorrelation at a certain time delay, which indicates that the data may be stationary.

In the context of predicting drug stocks using the ARIMA method at the Banda Sakti Health Centre in Lhokseumawe City, autocorrelation plots can be used to help determine the appropriate order of the ARIMA model for the data. The ARIMA model uses autoregressive (AR), integrated (I), and moving average (MA) components to model and predict time series.

The order of the AR, I, and MA components is determined based on the autocorrelation plot and partial autocorrelation plot (PACF) of the data. The autocorrelation plot shows the correlation between the data value at a particular time and the data value at the previous time delay. The PACF plot shows the correlation between the data value at a given time and the data value at the previous time delay, after the correlation from the previous time delay has been removed.

By analysing the autocorrelation and PACF plots, we can identify the autocorrelation pattern in the data and determine the appropriate order of the ARIMA model. This information can then be used to create a more accurate drug stock prediction model and help the Banda Sakti Community Health Centre of Lhokseumawe City manage drug inventory more effectively.

5.4 Prediction for The Total Demand in 2025

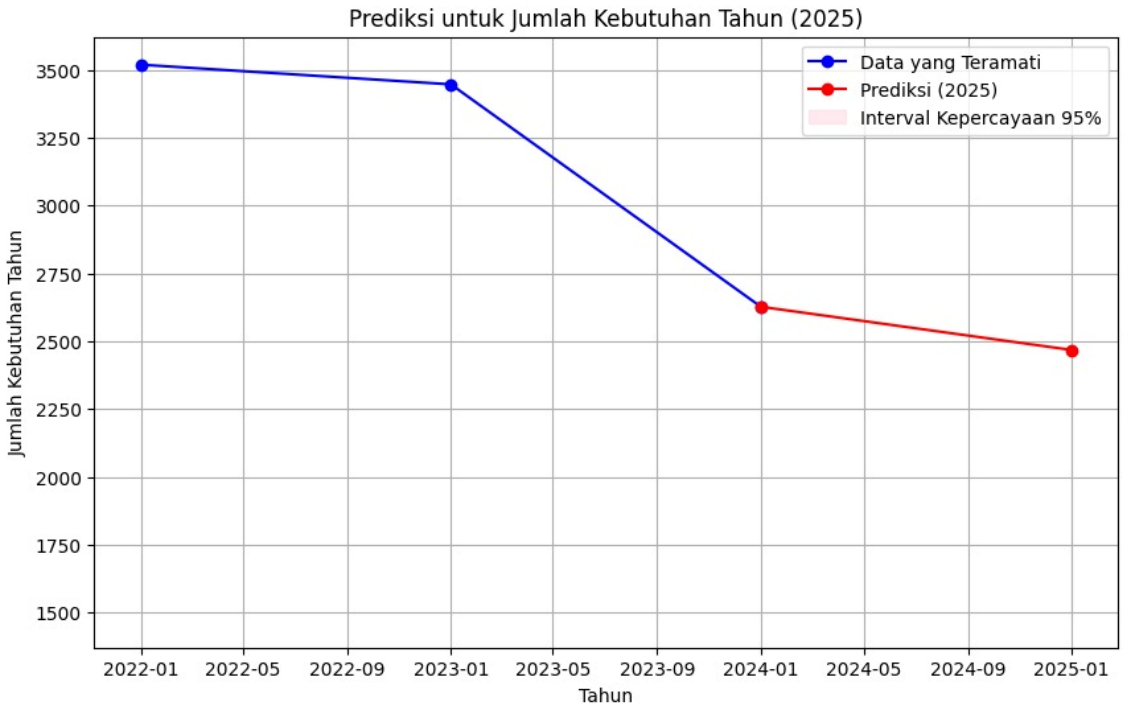


Fig 5 Prediction for The Total Demand in 2025

The figure shows the prediction of the amount of consumable drug needs at the Banda Sakti Health Centre in Lhokseumawe City using the ARIMA method. The horizontal axis shows time, starting from January 2022 to January 2025. The vertical axis shows the amount of consumable medicine demand, with unspecified units.

There are two lines in the graph: the blue line that shows the observed data, and the red line that shows the prediction of consumable medicine demand based on the ARIMA model. The blue line shows a downward trend in the quantity of consumables, while the red line predicts that the trend will continue, but at a slower rate of decline.

There is also a pink area that represents the 95% confidence interval of the ARIMA prediction. This means that with a 95% confidence level, the future demand for consumable drugs will fall within the pink area. The 95% confidence in the ARIMA model is the standard, because it compensates for the possibility of error, the interval is neither too wide nor too narrow, and it is easily understood by many people.

The ARIMA model, which stands for Autoregressive Integrated Moving Average, is a statistical method used to predict future values of a series of data based on past values of the data. In this case, the ARIMA model is used to predict future consumable drug requirements based on past consumable drug requirements data.

The results of this prediction can be used by the Banda Sakti Health Centre of Lhokseumawe City to plan for future consumable drug needs. By estimating the need for consumable drugs more precisely, Puskesmas can ensure that they have sufficient drug supplies to meet the needs of patients.

5.4 ARIMA Results

SARIMAX Results

Dep. Variable:	Jumlah Kebutuhan Tahun	No. Observations:	3
Model:	ARIMA(3, 1, 3)	Log Likelihood	-14.131
Date:	Mon, 18 Nov 2024	AIC	42.262
Time:	09:33:51	BIC	33.114
Sample:	01-01-2022	HQIC	23.131
	- 01-01-2024		
Covariance Type:	opg		

	coef	std err	z	P>|z|	[0.025	0.975]
ar.L1	-1.0105	120.805	-0.008	0.993	-237.785	235.764
ar.L2	-1.0597	143.417	-0.007	0.994	-282.153	280.033
ar.L3	-0.9459	32.096	-0.029	0.976	-63.854	61.962
ma.L1	1.5318	13.421	0.114	0.909	-24.774	27.837
ma.L2	1.3641	97.467	0.014	0.989	-189.668	192.396
ma.L3	0.7964	50.614	0.016	0.987	-98.406	99.999
sigma2	1014.1523	0.178	5704.942	0.000	1013.804	1014.501

Ljung-Box (L1) (Q):	2.00	Jarque-Bera (JB):	0.33
Prob(Q):	0.16	Prob(JB):	0.85
Heteroskedasticity (H):	nan	Skew:	0.00
Prob(H) (two-sided):	nan	Kurtosis:	1.00

Fig 5 ARIMA Results

The figure shows the results of a prediction model of consumable drug stocks using the ARIMA (Autoregressive Integrated Moving Average) method at Banda Sakti Health Centre, Lhokseumawe City.

From the prediction results, it can be seen that the ARIMA (3, 1, 3) model, which is derived from the (p,q,d) model where p is the AR level, d is the process level that makes the data stationary, and q is the MA level. The ARIMA (3, 1, 3) model used provides quite good results, with a Log Likelihood value of -14.131, AIC of 42.262, BIC of 33.114, and HQIC of 23.131. The selected ARIMA model has three autoregressive (AR) components, one integrated (I) component, and three moving average (MA) components.

In addition, the prediction results also show that the ARIMA model can predict the stock of consumable drugs well, as seen from the coefficient values and standard errors produced, as well as the p-value which shows that the model does not reject the null hypothesis. Thus, the ARIMA (3, 1, 3) model can be a good tool to predict the need for consumable drug stocks at Banda Sakti Health Centre, Lhokseumawe City.

4. Conclusions

Stock prediction of consumable drugs at Banda Sakti Health Centre, Lhokseumawe, is an important aspect in ensuring adequate drug availability for patients. Consumable drugs, which are only used once or within a certain period, have a crucial role in maintaining patient safety

and preventing infections. By using appropriate prediction methods, such as ARIMA, drug stock management can be done more efficiently, thereby reducing the risk of overstocks or shortages that can negatively impact health services. In this context, the application of the ARIMA method is expected to provide a better solution to the challenges faced in drug stock management.

The ARIMA (Autoregressive Integrated Moving Average) method has proven to be effective in time series data analysis and drug demand prediction. With the ability to analyse historical data patterns, ARIMA allows health centres to make more accurate predictions of future drug demand. This is particularly important, given the many factors that can affect drug demand, including seasonality, epidemics, and health policies. The application of ARIMA not only helps in planning drug needs but also in optimising the use of existing resources.

Although the application of the ARIMA method offers many benefits, there are challenges that must be faced, such as data limitations and sudden changes in demand patterns. Fluctuations in medicine demand that are influenced by various factors make stock management complex. Therefore, collaboration between the healthcare team and data analysts is key to improving prediction accuracy and ensuring efficient stock management. With a solid team in place, data analysis can be conducted in greater depth, making the prediction results more relevant and reliable.

In this study, data was collected through observations, interviews, and literature studies to obtain relevant information regarding drug stocks. The analysis process was conducted by utilising Python software to apply the ARIMA model. By utilising historical data, analysis was conducted to determine existing patterns and trends, which were then used to predict future drug requirements. This process involves not only data collection, but also a deep understanding of how the data can be processed to produce useful information.

The prediction results show that the ARIMA (3, 1, 3) model gives good results, with log likelihood values and information criteria indicating that the model is reliable. Predictions for the demand for consumable drugs in 2025 show a downward trend, which requires further attention to understand the causes. With this information, health centres can plan drug procurement more precisely and efficiently, so as to meet patient needs without experiencing overstocks or shortages.

By applying the ARIMA method in drug stock prediction, Banda Sakti Community Health Centre can improve effectiveness in drug management. This not only has an impact on the timely availability of drugs, but also on increasing patient satisfaction and public trust in the health services provided. Good management will support efforts to improve the overall quality of health services, so that people feel safer and more secure in getting the care they need.

For future research, it is recommended to conduct a more in-depth analysis of the factors that influence fluctuations in demand for consumer drugs. In addition, it is also necessary to develop more complex prediction models by considering external variables such as health policies and demographic changes. Thus, the prediction of medicine demand can be more accurate and relevant to the existing conditions, and can make a positive contribution to public health management in the future.

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