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FORECASTING DRUG SALES AFTER THE COVID-19 PANDEMIC IN PT. GRATIA HUSADA FARMA USING ARIMA METHOD

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ABSTRACT

Forecasting is the initial stage in production planning and serves as a foundation for subsequent production activities. The advent of the Covid-19 pandemic in Indonesia began in 2020, causing unstable sales. The ARIMA or Autoregressive Integrated Moving Average method is a medium-term forecasting method that generates relatively good prediction values compared to other methods. PT Gratia Husada Farma is a company active in the pharmaceutical field in Central Java. The sales data possessed by PT GHF is not yet optimally utilized and only serves as historical records. Through the obtained data, a sales forecasting analysis is conducted using the ARIMA method with parameters p, d, q of 1, 0, 1. Evaluation of the method using the RMSE formula results in a value of 2.229 (0.02229). This shows that the ARIMA method analysis has an acceptable error value, less than one of the critical values or alpha of 0.05.

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1. INTRODUCTION

The development of the medical field in the world, especially medicine, is growing with the passage of time. According to Pharmaceutical Law No. 7 of 1963, medicinal products are made from animal, plant, mineral and synthetic ingredients. The drug works as a drug when used correctly in the treatment of diseases at the right dosage and time. Public expectations for the quality and safety of pharmaceutical supplies are also increasing. The most important aspect in pharmaceuticals is inventory management with drug inventory optimization which includes planning, procurement, storage, distribution, selection of raw materials and management [1]. Since Covid-19 entered Indonesia, the Indonesian government has declared a state of emergency from February 29, 2020 to May 29, 2020 to deal with the Corona pandemic. This is done so that the government can solve this pandemic through *social* distancing campaigns or socialization *of physical distancing*. This is a limitation of social interaction between people and activities that involve many people or groups for Indonesian society [2].

The pharmaceutical industry has the greatest role and responsibility in terms of efficacy, safety, quality, and quality of drugs. PT Gratia Husada Farma is a company engaged in the pharmaceutical industry that produces medicines under the Hufa trademark, one of which is Hufagrip Flu & Cough Syrup. At the research site of PT Gratia Husada Farma, one of the drug suppliers in Semarang Regency and its surroundings. The medicine studied is the Hufa brand which is Hufagrip Flu & Cough Syrup. Hufagrip Flu & Cough sales increased during the Covid-19 pandemic before declining in early 2022, based on monthly sales data the company received. The instability of sales makes it difficult for PT Gratia Husada Farma to predict what products will be sold in the future. The problem today is that the pharmaceutical sales experience has its ups and downs every month, and it is difficult to predict an increase or decrease in sales, accumulation, expired drugs, and drug damage. Therefore, a research process is being carried out to find a suitable sales forecasting solution for PT Gratia Husada Farma using predictive technology to overcome these problems. Forecasting is very important to do before producing an item. Decision making is an appropriate technique for predicting what will happen in the future, using past data as an important reference. Forecasting also has the advantage of accurately forecasting sales at a certain time by prioritizing product production plans according to sales forecasts. Forecasting is generally necessary when the market demand situation is dynamic and complex. Forecasting techniques are used in production control to make various decisions. Of course, process and capacity planning are directly related to planning, inventory and scheduling [3].

Based on the existing problems, being able to use the forecasting method will provide results in the form of predictions of future sales which can then provide input in the form of recommendations for the amount of inventory that will be needed and make sales optimal. Based on chronological cycles or time series, product sales tend to form sales patterns, so forecasts can be calculated on a stronger and clearer basis, and the desired result is more objective than mere speculation.

2. LITERATURE REVIEW

The ARIMA model is a model that completely ignores free variables in forecasting. ARIMA uses historical and present values of dependent variables to create accurate short-term forecasts. But for long-term forecasting, forecasting accuracy is not good. The ARIMA model is divided into 3 elements, namely the *autoregressive* (AR), *moving average* (MA) and the integrated model (I). These three elements can be modified to form new models, namely the *Autoregressive* Model and *the Moving Average* (ARMA). The general form of this forecasting model is ARIMA (p, d, q), where p is the AR order, d is the integrated order, and q is the moving *averages* order. If the model becomes AR, then the model generally becomes ARIMA (1,0,0). According to Box Jenkins (1976) a non-stationary time series model can be said to be an integrated moving average of an autoregressive order process or ARIMA for short is an order of *autoregressive* parameters (AR) is a quantity that indicates how often differentiation is carried out in order for the process to be stationary and is a sequence of moving average (MA) parameters. In general the Box-Jenkins model is formulated using ARIMA notation (p,d,q), p is the AR order or degree (*Autoregressive*), d is the order or degree of differentiation, and q is the order or degree of MA (Movement).

In the research entitled "Analysis of Sales Forecasting of Medical Devices and Laboratories at PT. Tristania Global Indonesia Using the ARIMA Method "discusses the company can find out the prediction of the number of sales of its products in the future based on data in the past. Transaction data owned by PT. TGI has not been utilized optimally and is only a historical record so there needs to be further processing [4].

In the study entitled "Forecasting Drug Sales with the *Single, Double, and Triple Exponential Smoothing* Method (Case Study: Apotek Mandiri Medika)" this time discussed how the need for drugs will continue to increase along with the increasing number of people who know about it so that the need for medicines is needed. sale of drug availability. The process of collecting information for new information is known as forecasting. There are many ways to conduct research, this study uses *Single, Double,* and *Triple Exponential Smoothing Algorithms* as well as case study analysis. To determine which method is the best of the three algorithms will be compared [5].

In the study entitled "Forecasting Generic Drug Sales Through *Time Series* Forecasting Models at Pharmaceutical Companies in Tangerang: A Case Study" it was discussed that forecasting is a very important tool for business people to use in order to run more effective and efficient business operations in order to improve quality and productivity, including for Tangerang-based pharmacies that have special expertise in the field of generic drugs. The purpose of this study is to understand the best time series analysis method for analyzing pharmaceutical drug prices, as well as present the results of such analysis for the next period of time, namely from April 2020 to March 2021. The mean absolute deviation (MAD), mean *squared* error (MSE), and *mean absolute percentage* error (MAPE) are three measures of error obtained from the forecasting method [6].

In the study entitled "Green Tea Sales Forecasting with the ARIMA Method" this time discussed the ARIMA (*Autoregressive Integrated Moving Average*) Method as the only medium-term forecasting method that gives much better forecast results than medium-term forecasts. another method. The purpose of this study was to verify the assumptions made above and to determine the length of the next reflection period, with the object designated as the case study being the PT MK that produces green tea. The data used covers the months of January 2012 to December 2016, with Minitab used as a permutation calculator [7].

3. METHODS

The research process using the ARIMA method is described in general terms such as visualizing time series data, making time series data stationary, plotting correlation charts and Auto Correlation, building ARIMA models based on data and using models to make predictions. Ar model identification is best done with PACF. For AR models, the theoretical PACF "shuts" past the model sequence. The expression "deadly" means that in theory partial autocorrelation is equal to 0 beyond that point. In other words, the number of partial autocorrelations instead of zeros gives the sequence of the AR model. By "model sequence" we mean the most extreme lag of x used as a predictor. Identification of MA models is often best done with ACF rather than PACF. For MA models, the theoretical PACF is not turned off, but rather tapers towards 0 in some way.

A clearer pattern for MA models is in the ACF. ACF will have a non-zero autocorrelation only on the lag involved in the model, the value of p,d,q p of the AR model lagging d difference q MA lagging.

The stages of the study will be explained according to the research flow chart consisting of Data *Cleaning, Data Preparation, ARIMA Model*, Evaluation, Conclusion. Figure 1 shows the stages of the study.

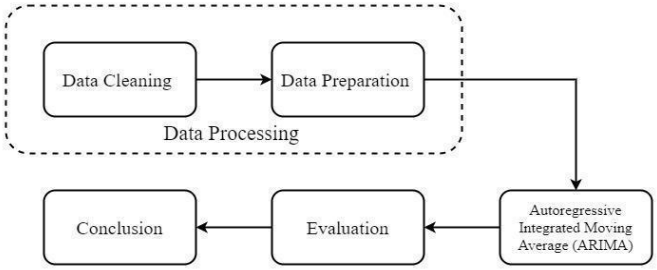

Figure 1. Stages of Research

The data source used is secondary data by collecting report data that has been compiled by the company, then the raw data obtained in the field is carried out a *cleansing* process or checking features with empty or unfilled values. Furthermore, a data preparation process is carried out for the selection of features with the best correlation values. After passing these two data *preprocessing*, the modeling stage continues, namely the implementation of the ARIMA method on data with parameters p, d, q (1,0,1). In this study, the sample used was generic drug sales data for the commodity product group for the period January 2019 – October 2022. Sampling is the process of selecting a number of elements from a population, so that their characteristics can be generalized to the population. This study used *purposive sampling*, which is the selection of samples based on criteria that have been determined by the researcher shown in Table 1.

Table 1. Drug Sales Data

Year	Hufagrip Flu & Cough Susp. 60ml	Hufagrip TMP Susp. 60ml	Hufagrip BP Syr. 60ml	Hufagrip Cold Syr. 60ml	H.Booster Susp. 50ml
2019	4.381.362	118.040	505.392	193.564	193.564
2020	5.342.588	960.948	4.449.070	1.512.546	9.587.413
2021	5.593.932	828.347	4.715.114	1.351.458	1.020.0819
2022	7.483.676	751.130	4.882.017	1.168.852	1.026.0374
Total	**22.801.558**	**2.658.465**	**14.551.593**	**4.226.420**	**3.024.2170**

The historical data on the sales of the selected drug is Hufagrip Flu & Cough Syrup packaged 60ml for the period January 2019 - October 2022. This product was chosen because it has a relatively stable level of sales. Table 2 shows Hufagrip Flu & Cough sales data for the period January 2019 - October 2022.

Table 2. Hufagrip Flu & Cough Sales Data for the Period of November 2019 - October 2022

	2019	2020	2021	2022
January	282.168	403.978	234.540	738.145
February	223.774	589.106	429.592	644.280
March	223.836	598.943	384.300	726.680
April	408.781	396.544	596.320	698.112
May	221.494	234.334	340.465	498.100
June	434.682	250.178	444.540	428.160
July	522.919	588.349	440.423	478.112
August	261.489	592.450	522.757	845.031
September	560.664	449.583	689.500	784.561
October	512.027	397.022	507.920	638.920
November	449.841	512.901	422.700	
December	279.687	329.200	580.875	

By knowing the sales data of Hufagrip Flu & Cough in the period January 2019 - October 2022, it can be used as the main capital to find out the results of future forecasts. Furthermore, the data are grouped by

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month and year as well as the number of drug sales. Figure 2 shows a 60ml Hufagrip Flu & Cough Syrup sales chart for the period January 2019 - October 2022.

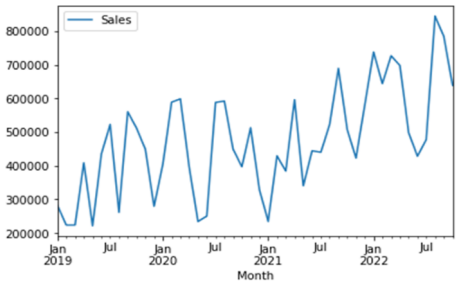

Figure 2. Hufagrip Flu & Cough Syrup Sales Chart 60ml Period January 2019 - October 2022

4. RESULTS AND DISCUSSION

The data obtained is sales data at PT. Gratia Husada Farma which starts in November 2019 until October 2022. Datasets are relational data that is *exported* into CSV form. The data is grouped by number of sales and year of sale. Furthermore, visualization / *plotting* is carried out to describe the condition of the sales data. Before that, the *Stationary Augmented Dickey-Fuller* (ADF) test was carried out to find out whether the time series data was stationary or not. If data is obtained that is not stationary, *differencing data* is carried out or calculating changes or differences in observation values. Figure 3 shows the results of the ADF statistical test.

```
#Uji Stationer ADF
adfuller_test(df['Seasonal First Difference'].dropna())
```

```
Statistik Uji ADF : -8.82329245910122
nilai-p : 1.8522565969541517e-14
#Lag Digunakan : 1
Jumlah Pengamatan yang Digunakan : 42
strong evidence against the null hypothesis(Ho), reject the null hypothesis. Data has no unit root and is stationary
```

Figure 3. ADF Statistical Test Results

The next process is to plot the autocorrelation function and the partial autocorrelation function. It can be used to determine the amount of lag used in an ARIMA model. The ACF and PACF plots are phases that test the correlation of data, regardless of whether the data is stationary. Both ACF and PACF are said to be non-stationary if the plot results have one or more lags above the significance line. To combat this, differentiation processing (d) is carried out. If the data is stationary, the value of d is set to 0 because the time series data is not differentiated. Figure 4 and Figure 5 show ACF and PACF graphs.

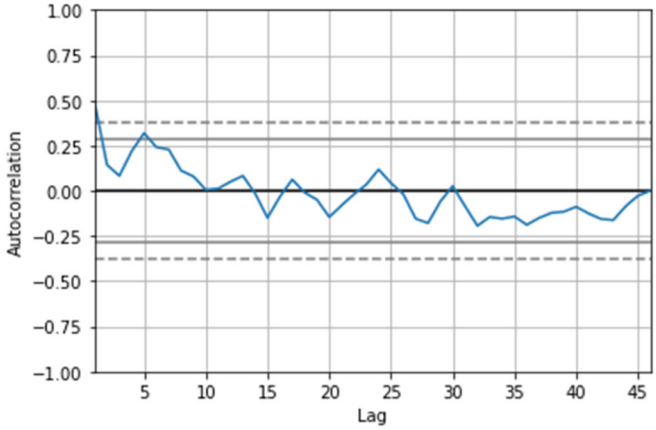

Figure 4. ACF Graph

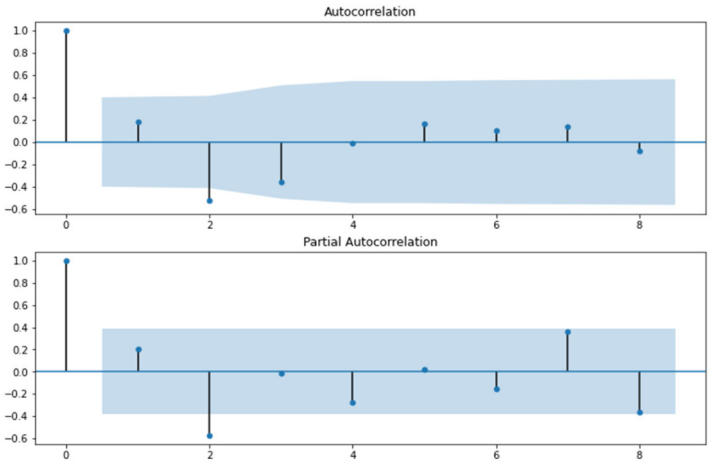

Figure 5. PACF Graphics

Based on the ACF and PACF graphs in Figure 4, the p-value can be estimated to be 1 (p=1), judging from the confluence of the graph's lines with horizontally transverse lines (firm lines). The parameter d can be seen from the trend line chart, which tends not to be straight (it can mean polynomial), for d which tends to be polynomial and quadratic can be set at 0 (d=0), for those whose tendency is straight can be set at number 1. As for the q parameter, it can be set starting from 1 for those with seasonal or 0 for those who do not have seasonal. After selecting the value of the p, d, q parameters against the ARIMA model, the next process is to implement the model against the existing data. The results show the predicted value and the value of the original data at each *time* and then visualize the data by plotting the sales value of the predicted results compared to the factual data. Figure 6 shows a visualization of the predicted sales value data rather than factual data.

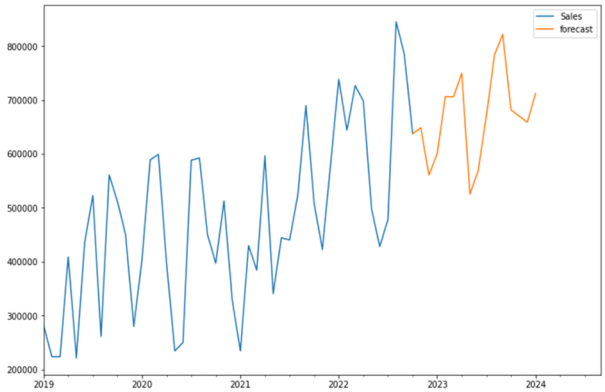

Figure 6. Visualization of Predicted Sales Value Compared to Factual Data

After calculating the data, an evaluation was carried out to measure the success of the ARIMA method performance (1,0,1). using *the Root Mean Square Error* (RMSE) calculation. The *resulting error* value is the difference between the predicted result data and the factual/original data. The *error* value can be used to calculate the RMSE value.

5. CONCLUSION

Drug sales forecasting after the Covid-19 pandemic can be done using the ARIMA method and provide good accuracy with minimal error rates. The results showed that the ARIMA method can be applied at PT Gratia Husada Farma with an error rate of 0.02229. By making such forecasting, it allows PT Gratia Husada Farma to make forecasting when needed and can be useful in forecasting surges and providing supply with sufficient capacity. This research can be further developed with other precision measurement methods that can be used in subsequent research to obtain more optimal and accurate comparison results.

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