

FORECAST ANALYSIS OF FRUIT SUPPLY USING TIME-SERIES METHOD: A STUDY AT PT AEROFOOD INDONESIA

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Abstract

PT Aerofood Indonesia operates in the aviation logistics industry, specifically as a partner of the Garuda Indonesia airline. The main problem is the tendency to have excessive supplies of raw materials, especially when purchasing fruit because it is susceptible to damage. This phenomenon often recurs and peaks beyond dry goods capacity limits, especially the availability of papaya fruit, which often exceeds capacity by more than 50%. Therefore, this research aims to identify the optimal forecasting method for papaya fruit to overcome the problem of excessive stock. This research tested four forecasting approaches: Trend Analysis, Single Average Exponential, Double Average Exponential, and Holt's Winter Method. Forecasting calculations were carried out manually and supported by Minitab 18 software. The research showed that Holt's Winter method with a multiplicative approach produced the lowest Mean Absolute Percentage Error (MAPE), 16%. Holt's Winter method, which uses a multiplicative approach, has proven effective in producing accurate forecasts. By implementing this recommended forecasting method, it is hoped that companies can be more efficient in managing inventory and reduce the impact of losses due to excess stock.

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1. Introduction

In the era of recovery from the COVID-19 pandemic that hit the world in 2020, many countries are starting to open their tourism doors again. The decrease in passengers results from lockdowns in several countries, including Indonesia, which has implemented PPKM (Implementation of Community Activity Restrictions) in many areas.

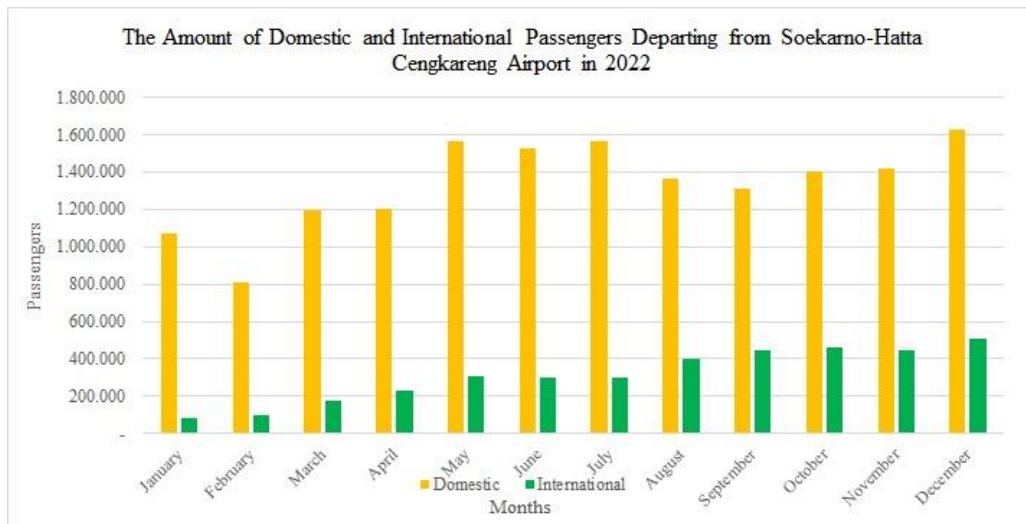


Figure 1. Data on Passenger Departures from Soekarno-Hatta in 2022 (BPS, 2022)

Based on Fig. 1 of the data above, it can be seen that the increase in domestic and international flight passengers is increasing as airlines start to increase their fleets to meet the increasing demand. PT Aerofood Indonesia, or Aerofood ACS (Aerowisata Catering Service), is a subsidiary of PT Aerowisata Group as part of the Garuda Indonesia Group subsidiary. The business led by ACS is a service company that provides services to meet aviation needs, including meeting the need for food—and cabin facilities.

The process of purchasing fruit is carried out every week, and delivery is done twice a week. Before being received, the goods will go through a quality assurance check under the specifications required by the company and then be stored in the fruit dry goods warehouse. Based on the results of informal interviews with storage supervisors, fruit often experiences an overstock phenomenon, which can result in financial losses and total capacity, and goods become unused because the shelf life for fruit is only 3 - 10 days. So, if an item is unused, it must be thrown away because it has rotted [1], [2].

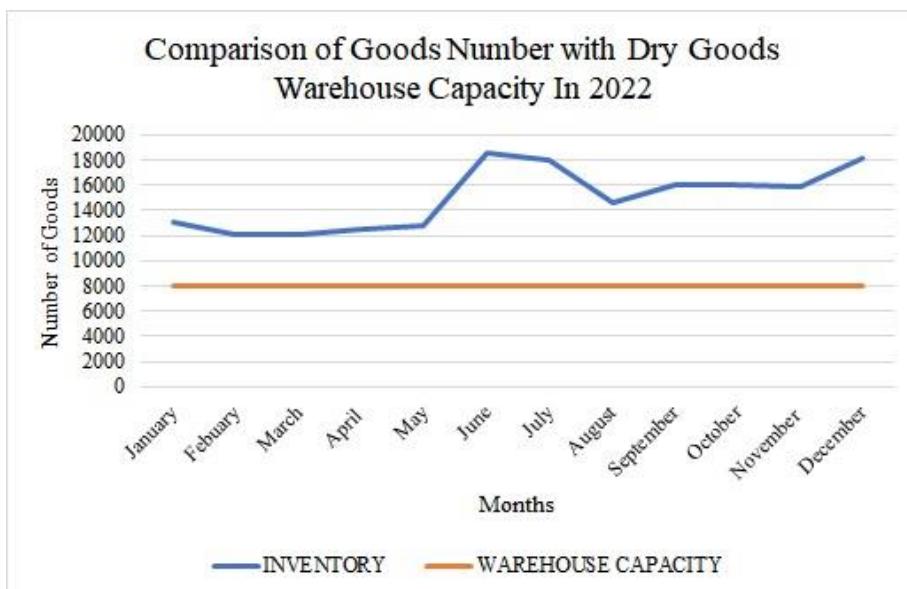


Figure 2. Comparison of Goods Number with Dry Goods Warehouse Capacity In 2022

Based on the data in Fig. 2 above, during 2022, there will always be overstock in the fruit dry goods warehouse, with an average of 50% of the total capacity in the warehouse. The fruit that often experiences

overstock is California papaya. Papaya fruit is one of the fruits that is considered an item that is often used in production.

According to [3], forecasting is a form of business that predicts future conditions by testing past conditions. Forecasting is a business function that attempts to estimate the sales use of products so that these products can be produced in a fixed quantity [4]. The forecasting or forecasting function is visible when making decisions [5]. A good decision is a decision that is based on considering what will happen when the decision is made [6]. Forecasting is carried out to determine the number of papayas that must be ordered to meet production needs. With many overstock incidents, it is hoped that this research can provide calculations in the theoretical application by using a forecasting method that suits the need to purchase goods to prevent a surplus in the supply of papaya fruit. The Holt Winter exponential smoothing method is used when the data shows seasonal trends and patterns. This method is similar to Holt's exponential smoothing method with additional equations to handle seasonal samples [7], [8]. In this research, the objective will be to identify the appropriate type of forecasting that can be carried out when ordering papaya fruit.

2. Literature Review

Forecasting is the art or science of predicting future events. It can be done by taking historical data and predicting it for the future using some form of systematic modeling. A combination of mathematical models adapted to the manager's good judgment can be used [3], [5]. Forecasts can be classified based on the time they cover in the future. Forecasts are usually classified based on the time they cover in the future. The time horizon is divided into several categories [9], [10], namely:

1. Short-term forecasting: period of less than three months to one year. Raw material purchasing plans, work schedules, job labor and production levels.
2. Medium-term forecasting for monthly periods of up to three years. For sales, production budgeting, and cash flow planning.
3. Long-term forecasting: for three years or more. This is for planning new products, capital expenditures, location or facility development, and research and development (Research & Development). (Taylor, 2009)

Time series forecasting occurs when scientific predictions are based on time-stamped historical data, which involves establishing patterns through historical analysis and using them to observe and guide future strategic decision-making. These methods are fit if the forecasting model reference does not change much from year to year [3], [11], [12]. It is a simple method to implement and will be a good starting point for forecasting demand. Time series data is commonly used in many other fields of science, one of which is supply chain management (SCM).

1. Single Exponential Smoothing Method

Exponential smoothing is a method that shows that the weights decrease exponentially compared to old observed values. Therefore, this method is called the exponential smoothing procedure. Like moving averages, exponential smoothing methods include single, multiple and more complex methods. They all have the same property: new values have a greater relative weight than old observed values [17].

2. Double Exponential Smoothing Method

Brownian double exponential smoothing is a linear model proposed by Brown. In the double exponential smoothing method, smoothing is done twice. It is possible to compute double exponential smoothing with just three data values and one value for α . The logic of the Brownian double-moving average is similar to the double-moving average in that the single smoothing and double smoothing values slow down the actual data whenever there is a trend factor. The difference between single and double smoothing can be added to the single smoothing value and adjusted to Trend [17].

3. Trend Analysis Method

Trend analysis is a statistical method that attempts to find a cause-and-effect relationship between causal or independent variables (X) and consequential variables (Y). Trend data is analyzed

and used to determine forecasts for the next period. Data migration trends can be linear, polynomial, exponential, logarithmic, or other, depending on the data sample being processed.

4. Holt Winter Method

According to [16], if the data contains trend and seasonal components, the Holt-Winters Exponential Smoothing method can be used, which requires three smoothing parameters, namely α (for process "level") β (for trend) γ (for seasonal ingredients). According to [17], the values of α , β γ will reduce MAPE (Mean Absolute Percentage Error). There are two Holt-Winters methods, namely the additive Holt-Winters method and the multiplicative Holt-Winters method.

Predictive calculations using quantitative data usually contain data in the form of time series, where forecasting techniques often go wrong [12], [13].

1) Mean Squared Deviation(MSD)

The first measure of overall forecast error for a model is the mean squared deviation (MSD) (Heizer and Render, 2004:113). This value is calculated by adding up the absolute value of each forecast error divided by the number of data periods (n).

2) Mean Absolute Deviation(MAD)

MAD is a second way to measure the accuracy of the estimated value of the model, which is applied to the form of the average absolute error.

3) Mean Absolute Percentage Error(MAPE)

The problem with MAD and MSD is that their values depend on the expected element size. The MAD and MSD values can be significant if forecast items are measured in thousands. To avoid this problem, we can use Mean Absolute Percentage Error (MAPE). It is calculated as the average absolute difference between the predicted and actual values, expressed as a percentage of the actual value (Heizer & Render, 2004). The forecasting carried out by Ayu Ariati (2020) entitled forecasting Using the Holt-Winters Exponential Smoothing Method (Case Study: Number of Foreign Tourists Visiting Indonesia) illustrates that the research that has been carried out shows that forecasting uses the Holt's Winter method with very high data patterns. Fluctuating produces a MAPE value of 0.983%, proving that the forecasting is appropriate and very accurate. With this research, the selection of three time-series forecasting methods can be determined by the results obtained on the error values in forecasting.

3. Method

In the research that will be carried out at PT Aerofood Indonesia (ACS), the author will make observations at the company first, then determine the formulation of the problems that occur at the company, determine the objectives of the problem formulation that has been carried out and continue to collect data thoroughly to carry out In-depth analysis using the Forecasting method with the Time series method and after finding the results, the results of the research will be presented along with writing conclusions and suggestions.

This research used Ms. Excel and Minitab 18 for data analysis. Calculations in Minitab 18 will provide an overview in the form of a graph and show directly the error value in forecasting. In this research, data collection was carried out qualitatively to obtain actual data that corresponds to reality. Qualitative research aims to understand a problem in depth so that recommendations can be made following the research findings by conducting interviews with stakeholders, making field observations, and collecting actual data.

The data that will be used in this research is data on the demand for papaya fruit in 2022 for 12 months. Data is obtained to assist in calculating forecasts for demand for the next 12 months. Although daily recommendations are more specific and detailed, there are several advantages to using aggregate data [7], [8].

- Long-Term Patterns and Trends

Monthly aggregate data can help identify long-term patterns and trends that may not be visible in daily data. It can provide a deeper understanding of fluctuations in fruit supply over time.

- Easier Data Processing

Monthly aggregate data is generally easier to manage and process than daily data. It can reduce the complexity of the analysis and produce more stable recommendations.

- Noise Reduction

Daily data often tends to have more significant fluctuations or "noise" than monthly data, using aggregate data that can reduce the impact of daily fluctuations that may not represent general trends in fruit supply.

3. Result and Discussion

Based on the calculation results above, it can be concluded that the selected forecast will use the smallest MAPE value. This selected forecast is Holt Winter's with optimal values $\alpha = 0.22$, $\beta = 0.55$, and $\gamma = 0.15$ and a MAPE result of 16%.

Based on the results of the forecasting calculations above, which produce almost the same MAPE values, this indicates that the type of forecasting that has been carried out is following the criteria of the forecasting method and the data criteria used in the form of trends and seasonality which produces almost the same MAPE values and there are no significant comparisons.

The trend and seasonal data patterns are very suitable for using Holt's Winter forecasting [14], [15] in research and indeed, following the data obtained in the research conducted above, the slightest error value in forecasting is obtained with Holt's Winter method which produces a MAPE of 16 %, then in this research it can be seen that the results calculated using actual data are following theory.

The selection of the latest forecasting method is also based on the significant value of MAPE in the current forecasting carried out at PT Aerofood Indonesia with the proposed calculations in this research. The following table uses the Holt Winter Multiplicative method to compare the company's forecasted MAPE value with the forecasted MAPE value. Table 1 compares the existing forecasting at PT Aerofood Indonesia and the forecasting selected for this research.

Table 1. Comparison of existing forecasts with selected forecasts

Types of Forecasting	MAPE	Category
Existing Forecasting	59%	Not accurate
Holt's Winter Multiplicative Method	16%	Good

Based on Table 1 above, forecasting using Holt's Winter Multiplicative method is better than the company's current forecasting. This forecasting aims again to reduce the excess stock of papaya fruit. It is hoped that this forecasting method will make it easier for PT Aerofood Indonesia, a method that is more suited to the fluctuating demand for this raw material product.

After carrying out the calculations, the values obtained in Table 1 are obtained with the forecasting results using the Holt Winter method, which are results that match the data pattern obtained. The following input can be provided to the company PT Aerofood Indonesia. In the planning part of purchasing goods, it is best to enter and use the selected theory in forecasting, in this case, using the Time-series method with four selected methods. The method obtained is Holt's Winter. Companies can use a calculation base obtained from historical data as a reference and consider seasonal times such as school holidays, Hajj / Umrah, religious days, and others. Also, with the increasing growth of airline passengers in Indonesia and the end of the COVID-19 pandemic, it is hoped that this will provide an indirect picture of the pattern of goods ordered. For example, making an application that makes forecasting easier can help workers calculate how many items should be ordered with a small expected margin of error, whereas, as a company, there has been no progress in using and utilizing application technology as a whole. The contribution to this research is in terms of the forecasting calculations carried out that several things can be changed in forecasting goods without having

to make significant investments on the company's part and provide convenience for workers, saving and disposing of unnecessary funds.

4. Conclusion

Research was carried out using the time series forecasting method (Time Series) to find the most optimal forecasting for papaya fruit. Forecasting will use four methods: trend analysis, single exponential smoothing, double exponential smoothing, and Holt Winter. The research uses data on the demand for papaya fruit during 2022, calculations by Ms. Excel, and Minitab 18 software. After carrying out the calculations, it can be seen that the smallest MAPE value is 16%, then the forecasting chosen uses the Holt Winter Multiplicative method with optimal values $\alpha = 0.22$, $\beta = 0.55$, and $\gamma = 0, 15$. So, forecasting papaya fruit at PT Aerofood Indonesia is recommended using the selected method, namely Holt Winter Multiplicative.

Several suggestions will be given for further research. First, this research is still relatively small because the data was processed for only 12 months, is still short-term, and can still be further developed in forecasting calculations with other items. There is still a gap between the results of manual calculations using Minitab 18 software. Second, this research can be developed into other goods, including how many necessities such as meat, vegetables and essential goods are needed for airplane logistics.

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