

# Aggregate Planning to Meet Perfume Box Demand With Minimum Cost in PT. XYZ

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## Abstract

The growth trend in world furniture exports, which has continued to increase over the last few years, has opened up opportunities for domestic business actors to increase market share and profits, one of which is PT. XYZ produces wood-based handicraft products in the form of perfume boxes for export to the Middle East market. In carrying out their business activities, companies often find it difficult to meet the increasing demand for perfume boxes, especially during peak seasons. Therefore, the researcher proposes an aggregate planning method using three strategies, namely chase strategy, level strategy and mixed strategy, to meet the demand for perfume boxes with minimum costs. The results of calculations that have been carried out show that a mixed strategy using the transportation method is the best strategy that will be applied to PT. XYZ because it can meet the demand for perfume boxes with a minimum cost of Rp. 4,531,944,000, saving Rp. 1,459,124,000 or 24.35% of the method currently used by the company during 2017.

## Keywords

Handicraft, Perfume Box, Peak Season, Chase Strategy, Level Strategy, Mixed Strategy

## 1. Introduction

The growth trend in world furniture exports, which has increased over the past five years, has made domestic and home decor industry players optimistic about seeing promising market opportunities. Data obtained from the Indonesian Wood Furniture and Handicraft Industry Association (HIMKI) shows that from 2013 to 2017, the average growth of world furniture exports reached 7.2 billion USD and is projected to continue to increase until 2020.

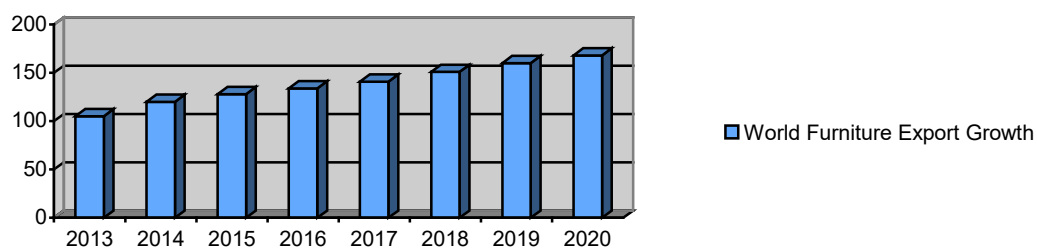


Figure 1. Growth Trends in World Furniture Exports

Indonesia, as one of the 20 world furniture exporters who is also the third-largest furniture exporter in the ASEAN region after Vietnam and Malaysia, is believed to be able to take advantage of this momentum to boost growth in furniture exports and wood and rattan-based handicraft products (Figure 1). Referring to the recapitulation data of the projected growth of the domestic furniture and craft industry issued by the Indonesian Furniture and Craft Association (AMKRI) and the Ministry of Industry for the next three years, both industries have a fairly positive growth trend, where this year the growth reached 2.70 billion USD for the furniture industry and 1.25 billion USD for the handicraft industry. In 2018 the growth will increase to 3.05 billion USD for the furniture industry and 1.45

billion USD for the handicraft industry. And in 2019, growth will again increase to 3.45 billion USD for the furniture industry and 1.68 billion USD for the handicraft industry.

The positive development of the two industries was also utilized by local furniture and handicraft business players, one of which was PT. XYZ is engaged in manufacturing wood-based handicraft products such as perfume boxes, corporate gifts and music boxes. For PT. XYZ, the Middle East market, is the main consumer who repeatedly orders the most handicraft products, especially perfume box products. The following supporting data that researchers get from the company:

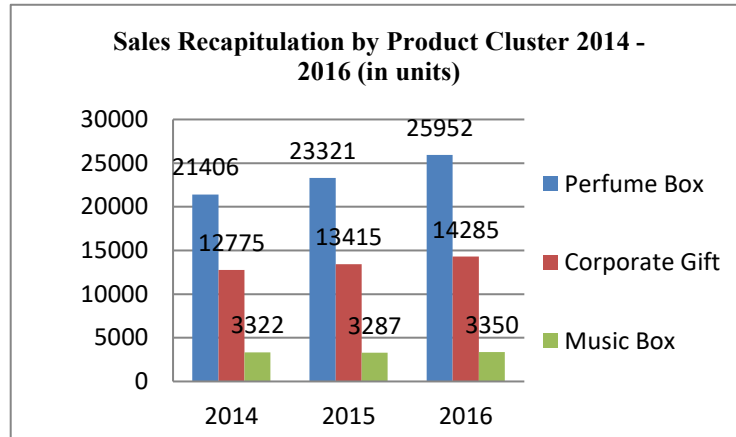


Figure 2. Number of Request Data Based on Product Clusters

Currently PT. XYZ experienced difficulties meeting fluctuating market demand, especially for perfume box products that received the most orders. Demand forecasting (demand forecasting) conducted by the company is still not accurate enough in projecting demand in the next period (Figure 2). This is because they only make a product when there is an incoming demand from consumers. As a result, when demand for perfume box products was high, especially during Ramadan and the pilgrimage, PT. XYZ had difficulty meeting that request. Whereas the forecasting method is very important to know the number of requests in the future, this is in line with the explanation of Heizer and Render (2012: 164), which says that forecasting is the only prediction about demand until the actual request is known. The following researchers attach data that compares the number of requests with perfume box sales:

Table 1. Data on Number of Requests and Sales of Perfume Box Products

Month	2014		2015		2016	
	Request	Sales	Request	Sales	Request	Sales
January	1650	1650	1700	1700	1850	1850
February	1780	1780	1775	1775	2100	2067
March	1750	1750	1800	1800	2200	2151
April	1825	1825	1950	1950	2150	2150
May	1900	1900	2000	1925	2200	2200
June	2100	1994	2500	2405	2800	2703
July	1970	1932	2350	2295	2650	2536
August	1600	1600	2100	1975	2300	2048
September	1890	1840	1875	1875	1900	1900
October	1625	1625	1700	1700	2200	2200
November	1820	1820	1950	1950	2000	1997
December	1690	1690	2000	1970	2150	2150
Total	21600	21406	23700	23321	26500	25952

If you look at the Table 1, the conditions under which PT. XYZ cannot fulfill the demand during peak season (high number of requests) often. This is certainly not cold because it has an impact on the loss of company revenue. In addition, in a journal written by Simamora and Natalia (2014: 353), it was explained that when a company cannot meet consumer demand continuously, it will cause a loss of consumer confidence which then turns to competitors. From the data obtained by researchers, it has been noted that over the past three years, the amount of potential revenue lost due to the sale of perfume boxes has not been able to meet consumer demand during peak season. In 2014 the potential value of lost income reached IDR 194,000,000. In 2015 it increased to IDR 305,000,000, and in 2016 it increased again to IDR 548,000,000. For completeness of the data can be seen in appendix 3. The researcher also calculated the amount of profits PT XYZ should have been able to obtain if the company was able to meet all requests in 2016 of 26,500 units. The calculation can be seen in the appendix.

In addition to the loss of potential revenue, there are also complaints (complaints) coming from some consumers who still perfume box perfume producers, namely Arabian Oud, Aljazeera Perfume, Swiss Arabian, Arabian Luxuries, Armaf and Khalis, who often cannot get the perfume box in the amount they want when demand for perfume in the Middle East is high (peak season). Therefore, the company needs to take an anticipatory step to solve the problem, which includes fulfilling perfume box requests when peak demand is high by considering cost efficiency and total revenue. To meet this demand, companies can use aggregate planning. By Heizer and Render (2012: 148), aggregate planning is explained as an approach to determining quantity and time of production in the medium term, usually 3 to 18 months. And also stated by Noegraheni and Nuradli (2016: 39) that if a company's production division has prepared resources to deal with fluctuations in demand for finished goods, production activities can run on time, and demand can be fulfilled. Operations managers try to determine the best way to meet the predicted demand by adjusting production values, labor levels, inventory levels, overtime workers, and other variables that can be controlled.

### **1.1 Problem Identification**

Based on the introduction above, the following identification of the problems faced by PT. XYZ, namely:

1. Inaccurate demand forecasting makes PT. XYZ did not know the number of perfume box requests in the coming period.
2. PT. XYZ could not meet the increasing demand when the demand for perfume boxes was high (peak season).

### **1.2 Problem Formulation**

Based on the identification of the problem above, the researcher can formulate the problem as follows:

1. What is the most accurate forecasting method for projecting the number of perfume box requests for the 2017 period along with peak season time?
2. What aggregate planning strategy can fulfill perfume box requests with minimum costs?

### **1.3 Scope**

The scope of this research is:

1. Perfume box products are manufactured by PT. XYZ. Researchers chose the perfume box because it is the best-selling product among other products produced by the company.
2. The study only focused on operational activities at PT. XYZ.

### **1.4 Goals**

This research specifically aims to:

1. Determine the number of demand forecasts per period of perfume box products produced by PT. XYZ.
2. Implement aggregate planning to meet the increasing demand for perfume boxes during peak season by considering the lowest cost.

### **1.5 State of The Art**

The following are related studies using the aggregate planning method which have been previously investigated by other researchers (Table 2).

Table 2. State of the Art

Authors	Journal	Research Discussion	Result
Enny Noegraheni, Hasbi Nuradli	<i>Aggregate Planning to Minimize Cost of Production in Manufacturing Company (Binus Business Review vol 7 (1) page 39 - 45 2016 ISSN: 2476-9050)</i>	<i>Aggregate Planning</i>	Aggregate planning using a linear regression approach can show an increasing trend every year, which requires forecasting in advance to anticipate increasing demand.
Simon Chinguwa, Ignatio Madanhire, Trust Musoma.	<i>A Decision Framework based on Aggregate Production Planning Strategies in a Multi Product Factory : A Furniture Industry Case Study (International Journal of Science and Research (IJSR) Vol. 2 (2) 2013 ISSN 2319-7064)</i>	<i>Aggregate Planning</i>	Aggregate planning method is able to overcome the problem of demand that exceeds regular production capacity.
Margaretha Gansterer	<i>Aggregate Planning and Forecasting in Make-to-Order Production Systems (Int. J. Production Economics vol 170 2015 page 521 - 528 ISSN: 0925-5273)</i>	<i>Aggregate Planning</i>	APP (Aggregate Production Planning) can be used in the medium term and aggregate planning is able to solve problems regarding production levels that are less than the demand from the market.
Dwi Puspita Sari Utami, Filda Rahmiati	<i>The Aggregate Planning for Trucking Operation in Cikarang Dry Port (The Asian Journal of Technology Management vol 8 (1) page 10 – 21 2015 ISSN: 1978 – 6956)</i>	<i>Aggregate Planning</i>	This study applies aggregate planning with overtime and subcontracting approaches and combines subcontracting and overtime approaches to find the lowest cost in distribution operations using trucks.
Chirag Deb, Fan Zhang, Junjin Yang, Siew Eang Lee, Kwok Wei Shah	<i>A Review on Time Series Forecasting Techniques for Building Energy Consumption (Renewable and Sustainable Energy Reviews vol 74 page 902-924 2017 ISSN: 1364-0321)</i>	<i>Forecasting</i>	Time series forecasting is useful for many things such as economic forecasting, quality control, census analysis, and others.
Bachtiar H. Simamora, Desty Natalia	<i>Aggregate Planning for Minimizing Costs : A Case Study of PT XYZ in Indonesia (International Business Management 8 page 353-356 2014 ISSN: 1993-5250)</i>	<i>Aggregate Planning</i>	This study calculates fluctuating seasonal demand and applies aggregate planning at PT XYZ to meet seasonal demand at the lowest cost.

## 2. Research Method

### 2.1 Forecasting

Forecasting is the art and science of estimating future events (Noegraheni & Nuradli, 2016: 39-45). This can be done by taking historical data and projecting it into the future in the form of a mathematical model. This can also be a subjective prediction of intuition. This can also be done by using a combination of mathematical models that are adjusted with the good judgment of a manager (Heizer & Render, 2012: 162). An almost similar understanding was also put forward by Assauri (2008: 47), which states that forecasting or forecasting is the art and science of predicting events that might be encountered in the future. Taylor (2013: 78) defines forecasting as a prediction of

what will happen in the future. Good forecasting is very important in all aspects of business: Forecasting is the only prediction about demand until the actual demand is known (Heizer & Render, Operations Management, 2012: 164).

a. Naive Approach

The naive approach is a forecasting technique that assumes the demand for the next period is the same as the request in the last period (Heizer & Render, 2012:170).

b. Moving Average

A moving average is a forecasting method that uses the average of the last period of data to predict the next period (Heizer & Render, 2012:170-171).

c. Exponential Smoothing

Exponential smoothing is a weighted moving average forecasting technique where the data points are weighted by an exponential function. Exponential smoothing is a method of forecasting moving averages with sophisticated weighting, but still easy to use. This method uses the recording of very little past data (Heizer & Render, 2012:174-175).

By exponential smoothing with trend adjustments, the average estimate and trend are smoothed. This procedure requires two smoothing constants,  $\alpha$  for the average and  $\beta$  for the trend. Then we calculate the average and trend for each period (Heizer & Render, 2012:181-182).

d. Linear Regression

Linear regression is a mathematical model in the form of a straight line that describes the relationship between dependent and independent variables. Time series linear regression forecasting is suitable for data that have trend patterns (Noegraheni & Nuradli, 2016: 40).

If we decide to make a straight trend line using the statistical method, we can apply the least square method. This approach produces a straight line that minimizes the sum of the squares of the vertical deviations of the line at each actual observation. The least-squares are explained by the intersection of the y-axis (where the graph crosses the y-axis) and the slope (the angle of the line) (Heizer & Render, 2012:185).

## **2.2 Calculation of Forecasting Errors**

The overall accuracy of each forecasting model can be explained by comparing the predicted value with the actual or observed value. There are several calculations commonly used to calculate total forecasting errors. This calculation can be used to compare different forecasting models, monitor forecasting, and ensure forecasting runs well (Heizer & Render, 2012: 177). The most famous calculations, namely:

1. *Mean Absolute Deviation (MAD)*

The first measure of overall forecasting error for a model is MAD. This value is calculated by taking the number of absolute values of each forecasting error divided by the number of data periods (n) (Heizer & Render, 2012:177).

2. *Mean Squared Error (MSE)*

This is the second way to measure overall forecasting errors. MSE is the average difference between the squares predicted and observed. Small MSE will be better because we want to minimize MSE (Heizer & Render, 2012:179).

## **2.3 Seasonal Variation**

Seasonal variations in data are regular movements both increasing and decreasing in certain periods of time-related to recurring events, such as weather or holidays. Seasonal variations can be applied in patterns observed in hours, times, weeks, months, or other repetitive patterns. Understanding seasonal variations is very important for capacity planning in an organization to handle peak loads (Heizer & Render, 2012:185).

Seasonal variations require forecasting trend line adjustments. Variation is expressed in the number of actual values that differ from the average value in the time series. Analyzing data on a monthly or quarterly basis usually makes it easy for statisticians to see seasonal patterns. Then the season index can be developed by several methods. With so-called multiplicative seasonal variations, the seasonal factor is multiplied by a prediction of average demand to produce seasonal forecasting. The steps for multiplicative variation are (Simamora & Natalia, 2014:354):

1. Find the average historical demand for each season by summing the demand for one month each year, divided by the number of years of data available.

2. Calculate the average demand for all months by dividing the average total annual demand by the number of seasons.
3. Calculate the seasonal index for each season by dividing the actual historical demand for the month (from the first step) by the average demand for the entire month (from the second step)
4. Estimate the total annual demand for the next year.
5. Divide the total annual demand forecast by the number of seasons, then multiply by the month's seasonal index. This results in seasonal forecasting.

## **2.4 Aggregate Planning**

According to Jacobs, Chase, and Aquilano (2009: 518), this planning is in the form of a business plan that contains a plan for the company's activities in the next 3 to 18 months. This business plan is based on forecasts of economic conditions, industry, or future competition and reflects the company's strategy in achieving its goals.

Meanwhile, according to Nahmias (2009: 125), aggregate planning can also be said as macro production planning. It can be seen from the company's problems in determining the employees that must be maintained as well as determining the quantity of production of various kinds of products. According to Simamora and Natalia (2014: 354), aggregate planning is the best planning for the utilization of human resources and equipment in meeting fluctuating demands because most aggregate planning methods determine a plan by minimizing costs. According to Jacobs, Chase, and Aquilano (2009: 518), the main objective of aggregate planning is to specify the optimal combination of production levels, levels of labor and available inventory. The level of production can be seen from the number of units that can be produced in units of time (hours or days). The level of labor is the amount of labor needed in a production ( $\text{production} = \text{level of production} \times \text{level of labor}$ ).

## **2.5 Aggregate Planning Costs**

According to Krajewski, Malhotra, and Ritzman (2015: 400) in the aggregate planning there are costs associated with the production process. The types of costs are:

1. Regular fee  
These regular costs consist of the cost of basic employee wages, health insurance, pension funds and other absentee costs.
2. Overtime expense  
Costs charged to work that exceed the regular work time limit, usually 150% of the cost of regular work time. Overtime activities can help companies avoid hiring new employees.
3. Recruitment and dismissal costs  
Includes the cost of job advertisements, interviews and training of new employees, and also the loss of productivity. Dismissal costs include severance costs and training of employees and managers there.
4. Storage fee  
Costs that follow variations in storage / warehouse: consist of warehouse costs for raw materials and finished goods, costs for theft and obsolescence and warehouse taxes.
5. *Backorder and stockout costs*  
Includes additional costs to pay for transportation of products that are past due, the cost of lost sales, as well as the potential costs of losing customers that cause customers to switch to competing products.

## **2.6 Aggregate Planning Strategy**

Heizer and Render (2012: 155) argue that many manufacturing companies assume that the use of demand choices has been thoroughly researched by marketing and that these viable options are incorporated into demand predictions. However, with five capacity choices in its authority, the operations manager still has many possible plans. There are three strategies in aggregate planning, which are (Simamora & Natalia, 2014:355):

1. *Chase strategy*  
Producing the number of goods in accordance with the number of requests per month.
2. *Level strategy*  
Producing the same amount of products every month for one year.
3. *Mixed strategy*  
Mixed strategy is a combination of chase and level strategy. This strategy takes advantage of both strategies to find ways to produce goods that are in line with regular, overtime and subcontracted production capacities so that they meet their monthly demand with minimum costs.

In this study, researchers will use three strategies namely chase strategy, level strategy and mixed strategy to find the lowest cost.

## 2.7 Data Collection Technique

There are several methods that researchers use to collect the data needed, viz:

1. Interview. Data collection techniques by interviewing authorized people and experts in the field of the object under study. The person can be a manager, supervisor or ordinary employee in the company.
2. Observation. Data collection techniques by observing conditions, phenomena and facts in the field related to the object of research.

## 3. Result And Discussion

Based on the results of research and the results of data processing analysis, the following conclusions can be concluded (Table 3):

Table 3. Forecasting Results

Method	Amount	MAD Value	MSE value
<i>Naive Method</i>	26.500 unit	2.450	6.125.000
<i>Moving Average</i>	23.933 unit	3.850	14.822.500
<i>Exponential Smoothing</i>	24.575 unit	2.975	9.616.250
<i>Exponential Smoothing with Trend</i>	25.800 unit	2.712,5	7.732.813
<i>Least Square</i>	28.833 unit	155,55	27.222,22

From the results of forecasting calculations that have been done, the researcher concludes that the most accurate forecasting method is the Least Square method because it has the smallest MAD and MSE values, namely 155.55 and 27.222.22. The projected demand for 2017 with the Least Square method alone is 28,833 units.

The next step the researcher needs to do is calculate the multiplicative seasonal variation method to find out the number of requests each month from the projected demand results with the Least Square method. Here are the results of the calculation (Table 4):

Table 4. Seasonal Calculation Results Table

Month	Request
January 2017	2088
February 2017	2271
March 2017	2309
April 2017	2379
May 2017	2448
June 2017	2972
July 2017	2797
August 2017	2525
September 2017	2167
October 2017	2208
November 2017	2335
December 2017	2345

### 3.1 Aggregate Planning Results

Aggregate planning is a method that researchers use to solve existing problems at PT XYZ, where companies have difficulty meeting the demand for perfume boxes during peak season with minimum costs. The researcher proposes three aggregate planning strategies, namely chase strategy, level strategy and mixed strategy. The following Table 5 are the results of the aggregate planning calculations conducted by researchers:

Table 5. Results of Aggregate Planning Calculations

	Chase	Level	Mixed
Regular	O	O	O
Overtime	O	O	
Subcontract	O	O	
Shortage		O	
Holding		O	O
Total Cost	Rp 4. 718.109.000	Rp 5.025.473.000	Rp 4.531.944.000

### 3.2 Results Implications

From the results of the calculation of aggregate planning with three strategies, the researcher concludes that a mixed strategy is the best strategy to be applied to PT XYZ. By using a mixed strategy, PT. XYZ can fulfill demand only with regular production capacity so that the total cost incurred becomes less. Previously, PT. XYZ uses a make-to-order system where the company carries out the production process when there is an incoming request which turns out; this system makes it difficult for the company to fulfill the demand for perfume boxes, especially during peak season, despite applying overtime and subcontracting hours.

### 4. Conclusion

Based on the analysis explained in the previous chapter, the researcher can conclude the following:

- The most accurate forecasting method is the least square method and the multiplicative seasonal variation method. The number of perfume box demand projections for the 2017 period is 28,833 units, where the highest demand occurring in June at 2,972 units.
- In calculating aggregate planning, researchers used three strategies, namely chase strategy, level strategy, and mixed strategy, to meet the demand for perfume boxes during the 2017 period with minimal costs. Based on calculations by researchers, a mixed strategy is the most appropriate strategy to be applied at PT. XYZ because it can fulfill the demand for perfume boxes in a timely manner with the lowest production cost compared to the other two strategies, which is IDR 4,531,944,000, saving IDR 1,459,124,000 or 24.3% of the methods currently used by PT. XYZ.

### 5. Suggestion

Suggestions that can be considered as input for companies are as follows:

- PT. XYZ must forecast demand with the least square method to find out how many perfume box requests are in the coming period. A good forecast can help companies determine the strategy of an effective and efficient production process.
- PT. XYZ must implement a mixed strategy that uses transportation methods to meet the demand for perfume boxes with minimum costs in the period 2017. The company must also anticipate fluctuating demand by imposing overtime and subcontracting when products produced by regular production capacity are unable to meet increasing demand.

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