Inventory control of raw material using silver meal heuristic method in PR. Trubus Alami Malang

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Abstract. The purpose of this study was to compare the total inventory cost calculated using the method applied by PR. Trubus Alami and Silver Meal Heuristic (SMH) method. The study was started by forecasting the cigarette demand from July 2016 to June 2017 (48 weeks) using additive decomposition forecasting method. The additive decomposition was used because it has the lowest value of Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD) compared to other methods such as multiplicative decomposition, moving average, single exponential smoothing, and double exponential smoothing. The forecasting results was then converted as a raw material needs and further calculated using SMH method to obtain inventory cost. As expected, the result shows that the order frequency of using SMH methods was smaller than that of using the method applied by Trubus Alami. This affected the total inventory cost. The result suggests that using SMH method gave a 29.41% lower inventory cost, giving the cost different of IDR 21,290,622. The findings, is therefore, indicated that the PR. Trubus Alami should apply the SMH method if the company wants to reduce the total inventory cost.

1. Introduction

The cigarette industry is one of the industries that contribute greatly to Indonesian income. According to the Directorate General of Customs and Excise [1], the country’s income from cigarette is IDR 76.3 trillion or 72.89% of the total Indonesian income of IDR 104.7 trillion in 2013. However, the local cigarette industries in Indonesia have decreased in number every year. This declined is possibly due to tight competition, tight regulations related to cigarettes, and an increase of annual excise tariffs. Thus, the cigarette industries need to resolve those threats, for example, by reducing the production costs and improving the operational efficiency [2]. PR. Trubus Alami Malang is one of the companies producing cigarettes with brand SKT (Sigaret Kretek Tangan) Trubus Alami cigarettes. Currently, the demand for SKT Trubus Alami cigarettes is fluctuated every month. Therefore, the material requirement planning and the raw material inventory control in PR. Trubus Alami are currently estimated based on the previous requirements. By doing this practice, thus the company often experienced an excess in raw material inventory which may lead to the waste problems. The optimal and efficient methods to control the inventory is therefore critical.

Lot-sizing heuristic methods can be used to tackle the those inventory problems in PR. Trubus Alami. One of the lot-sizing heuristic methods is Silver Meal Heuristic (SMH), which is a method used to determine the lot size of the orders by carefully examined the inventory costs. Each productive
system manager knows that finding the optimal trade-off between reducing inventory and decreasing the frequency of production/replenishment orders allows a great cut-back in operations costs [3]. This method is more appropriately applied under fluctuating demand conditions [4]. This research was aimed at comparing the total inventory cost calculated using the method applied by PR. Trubus Alami and using the SMH method.

2. Research Methods
In this research, the demand forecasting was carried out using five time series methods include multiplicative decomposition, additive decomposition, moving average, single exponential smoothing, and double exponential smoothing. The selection of the forecasting methods was carried based on their error values, calculated using the smallest error comparison analysis of the Mean Absolute Deviation (MAD), Mean Squared Deviation (MSD), and Mean Absolute Percentage Error (MAPE) [5].

2.1 Product demand forecasting
The sales data used in this study was from the period of July 2014 to June 2016 (96 weeks), which was then used as an initial data to forecast the product demand. Product demand forecasting was estimated using the demand data of SKT Trubus Alami from the period of July 2016 to June 2017. The product demand forecast was then interpreted as the raw material requirement, and listed as a bill of materials (BOM).

2.2 Calculation of raw material requirement
A BOM was used to describe the requirement of the raw material in the company needed to produce SKT Trubus Alami.

2.3 SMH
The SMH finds the lowest average cost per period [6]. The main equation used is as follows:

$$\frac{TRC(T)}{T} = \frac{C + Ph \sum_{k=1}^{T}(k - 1)Rk}{T}$$

Where:
- $C$ = ordering cost per period
- $TRC (T)$ = total relevant cost in period $T$
- $T$ = addition time in period
- $Ph$ = holding cost per period
- $P$ = purchase cost per unit
- $Rk$ = demand level of period $k$

2.4 Safety stock calculation and reorder point

2.4.1 Safety stock.
Safety stock is defined as inventory that is carried to prevent stock out and back order situations. [7], was carried out using the following formula [8]:

$$S = k\sqrt{LT(\sigma d^2)}$$

Where:
- $SS$ = safety stock
- $LT$ = lead time
- $k$ = safety factor
- $\sigma d$ = standard deviation
2.4.2 Reorder point.
The calculation of reorder point, aimed at identifying the rate of re-ordering of the raw materials, was performed using the following formula [9]:

\[ ROP = d \times L + SS \]

Where:
ROP = reorder point
L = lead time
d = demand per unit time
SS = safety stock

2.5 Comparison method
The obtained data were analysed by comparing the total inventory cost, which was counted using the SMH method and the company’s method.

3. Results and Discussion
3.1 Demand Forecasting Results
Figure 1 shows the product’s sales of SKT Trubus Alami Cigarettes from July 2014 to June 2016. The figure indicates that the cigarette sales were fluctuated, following the seasonal pattern. Despite a sharp decrease in week 51 with the value of less than 100,000 packages in general the average sales every week was in the range of 200,000 - 600,000 packages.

![Figure 1](image)

**Figure 1.** Sales of SKT Trubus Alami Cigarettes from July 2014 to June 2016

The error values for each forecasting method can be seen in Table 1. The table shows that the additive decomposition method had the smallest MAD, MSD and MAPE values compared to other methods. This was because the additive decomposition is an appropriate method for the time series data that is influenced by seasonal patterns and trends [10]. Therefore, the additive decomposition method was selected to be used for forecasting the product demand based on the sales values, and the result is shown in Table 2.
Table 1. Comparison of forecasting error values.

| Forecasting Method                  | Error Value | MAPE (%) | MAD   | MSD          |
|-------------------------------------|-------------|----------|-------|--------------|
| Multiplicative Decomposition        |             | 19       | 57,018| 5,956,036,618|
| Additive Decomposition              |             | 19       | 56,849| 5,836,706,578|
| Moving Average                      |             | 25       | 62,734| 7,558,919,593|
| Single Exponential Smoothing        |             | 25       | 64,656| 7,953,587,513|
| Double Exponential Smoothing        |             | 33.59    | 85,469| 14,131,100,000|

Table 2. Additive decomposition forecasting results.

| Period | Sales (packages) | Period | Sales (packages) | Period | Sales (packages) | Period | Sales (packages) |
|--------|------------------|--------|------------------|--------|------------------|--------|------------------|
| 1      | 429,105          | 13     | 551,408          | 25     | 379,830          | 37     | 443,336          |
| 2      | 470,927          | 14     | 416,007          | 26     | 473,052          | 38     | 507,369          |
| 3      | 470,341          | 15     | 407,780          | 27     | 481,001          | 39     | 620,200          |
| 4      | 421,311          | 16     | 449,387          | 28     | 435,401          | 40     | 421,273          |
| 5      | 411,647          | 17     | 411,535          | 29     | 575,295          | 41     | 469,683          |
| 6      | 475,680          | 18     | 525,286          | 30     | 427,891          | 42     | 482,965          |
| 7      | 588,511          | 19     | 277,995          | 31     | 420,454          | 43     | 515,221          |
| 8      | 389,584          | 20     | 336,191          | 32     | 414,331          | 44     | 520,090          |
| 9      | 437,995          | 21     | 555,259          | 33     | 460,794          | 45     | 583,097          |
| 10     | 451,276          | 22     | 492,337          | 34     | 502,615          | 46     | 447,695          |
| 11     | 483,532          | 23     | 471,488          | 35     | 502,029          | 47     | 439,468          |
| 12     | 488,402          | 24     | 506,344          | 36     | 452,999          | 48     | 481,076          |

3.2 BOM of SKT Trubus Alami Cigarettes

BOM of SKT Trubus Alami cigarettes can be seen in Table 3. The table shows that there were 13 ingredients required to produce the cigarette products. From these materials, nine materials were purchased, while four materials were resulted from the production process. The data from BOM and the demand forecast for SKT Natural Trubus Cigarettes were then used to determine the requirement of each raw material from July 2016 to June 2017.

Table 3. BOM of SKT Trubus Alami Cigarettes.

| Item           | Number of Unit | Unit | Description | Item           | Number of Unit | Unit | Description |
|----------------|----------------|------|-------------|----------------|----------------|------|-------------|
| Cigarettes pack | 1              | package | Product | Clove   | 0.005073 | kg | Purchase |
| OPP Plastic Packaging | 1 | piece | Purchase | TSS | 0.016909 | kg | Process result |
| Etiquette paper | 1          | sheet | Purchase | Sauce | 0.000343 | kg | Purchase |
| Cigarettes | 12        | pieces | Process result | TSL | 0.017135 | kg | Process result |
| Glue     | 0.000326 | kg | Purchase | Fine Tobacco | 0.010559 | kg | Purchase |
| Ambri paper | 12    | sheets | Purchase | Rough Tobacco | 0.005280 | kg | Purchase |
3.3 Inventory Cost
In this study, the inventory costs calculated include ordering and holding costs. The ordering costs made by the company consisted of transportation costs, loading and unloading costs, and administrative costs (Table 4). The holding costs in the company consisted of lighting costs, PBB (or Land and Building Tax) fees, and cleaning costs (Table 5). Based on Table 4, it can be seen that both tobacco and clove materials were ordered by the company in a single order because they were bought from the same suppliers. While, other raw materials (i.e. sauce, glue, ambient paper, etiquette paper, and OPP plastic packages) were ordered twice a week.

3.4. Results of the Inventory Calculation in The Company
The results found that the quantity for the ordering and the safety stock of each material were based on the average end product demand of 80,000 packages / day or 480,000 packages / week. The inventory cost incurred by the company from July 2016 to June 2017 was IDR 72,400,538. In this case, the inventory control of raw material applied by the company was relied on a constant-time inventory. Also, the company applied 1 week of safety stock for tobacco and clove materials, as well as a minimum of 0.5 weeks of safety stock for sauce, ambient paper, etiquette paper, OPP plastic packaging, and glue.

| Table 4. Ordering cost. |
|------------------------|
| Ingredient | Ordering Cost (IDR per order) | Ingredient | Ordering Cost (IDR per order) |
|            | 1x order | Per ingredient | 1x order | Per ingredient |
| Fine Tobacco | 269,107 | | Ambri Paper | 312,500 | 312,500 |
| Rough Tobacco | 577,789 | 134,554 | 44,851 | | | | | | | |
| Virginia Tobacco | 312,500 | 0.001760 | | | | | | | |
| Clove | 129,277 | | OPP Plastic Packaging | 345,846 | 345,846 |
| Sauce | 312,500 | 312,500 | Glue | 312,500 | 312,500 |

| Table 5. Holding cost. |
|------------------------|
| Ingredient | Storage Cost (IDR/week) | Unit | Ingredient | Storage Cost (IDR/week) | Unit |
| Fine Tobacco | 7.49088 | kg | Ambri Paper | 0.00233 | sheet |
| Rough Tobacco | 7.49088 | kg | Etiquette Paper | 0.03349 | sheet |
| Virginia Tobacco | 7.49088 | kg | OPP Plastic Packaging | 0.03349 | pieces |
| Clove | 5.22044 | kg | OPP Plastic Packaging | 51.78490 | kg |
| Sauce | 16.28491 | kg | OPP Plastic Packaging | 345,846 | 345,846 |

3.5. The Results of SMH Method Calculation
Using the SMH method, the requirement of tobacco and clove materials was separately calculated, resulted in an ordering cost for three types of tobacco and clove materials at a value of IDR 577,789. The limit of the order capacity of 14,400 kg per order was also considered when calculating the cost for tobacco & clove materials, as shown in Table 6.
Table 6. SMH calculation result.

| Combination Period | Lot Size Cumulative (kg) | Total Cost (IDR) | TRC/T (IDR) |
|--------------------|--------------------------|------------------|-------------|
| 1                  | 4,531                    | 577,789          | 577,789     |
| 1, 2*              | 9,504                    | 615,039          | 307,520     |
| 1, 2, 3            | 14,470                   | 689,447          | 229,816     |
| 3                  | 4,967                    | 577,789          | 577,789     |
| 47.48*             | 9,720                    | 615,842          | 307,921     |

Note: * = optimal

Table 6 indicates that the ordering of combinations of period 1,2 was more optimal than that of periods 1,2,3, although the TRC / T value of the period 1,2 was smaller than that of the period 1,2. This is because the lot size booking combination of period 1,2,3 has exceeded the order limit of 14,400 kg. SMH calculation can be performed even though the lowest cost value has not been reached. The total inventory cost resulted from SMH method was IDR 49,186,661, lower than that of calculated using the company’s method. This indicated that applying SMH method can generate an effective ordering period and an optimal order amount, with a minimum total cost per period.

3.6. Calculation Result of Safety Stock

Lead time of tobacco and cloves was 1.67 weeks and for other materials was 2.33 weeks. The value of service level used in the company was 95%. The results of the safety stock calculation for each raw material were 1,421 kg of fine tobacco, 710 kg of rough tobacco, 237 kg of Virginia tobacco, 683 kg of cloves, 55 kg of sauce, 1,910,379 sheets of ambri paper, 159,198 sheets of etiquette paper, 159,198 pieces of OPP plastic packaging, and 52 kg of glue.

3.7. Calculation Result of Reorder Point

Reorder point of each raw material was 9,625 kg of fine tobacco, 4,813 kg of rough tobacco, 1,604 kg of Virginia tobacco, 4,624 kg of cloves, 427 kg of sauce, 14,963,332 sheets of ambri paper, 1,246,944 sheets of etiquette paper, 1,246,944 pieces of OPP plastic packaging, and 407 kg of glue.

3.8. Comparison Result of Inventory Methods

By using the SMH method, the ordering cost was IDR 35,736,711, the holding cost was IDR 15,373,165 and inventory cost was IDR 51,109,875. While, the calculation results using the company’s method demonstrated that the ordering cost was IDR 66,034,200, the holding cost was IDR 6,366,337 and inventory cost was IDR 72,400,538. The total savings that can be made with SMH method was 21,290,663 or 29.407%, possibly due to a lower cost of ordering using SMH method was much lower than the cost of ordering using the company’s method. Furthermore, the savings on SMH orders cover the larger holding costs of the company. This is related to the frequency of orders made on the SMH method. This study revealed that the ordering frequency obtained by SMH is lower than the company. The SMH is the optimum method for the company than others methods. This is because SMH method combines several booking periods in one booking period. The high of ordering frequency can have an impact on the lower cost of ordering, but it may result in higher holding costs due to the high amount of material stored [11].

4. Conclusion
The PR. Trubus Alami undertakes inventory control by ordering every 1 week of fine tobacco, rough tobacco, Virginia tobacco, and cloves with a safety stock of 1-week requirement. The inventory control of raw material for production of SKT Trubus Alami Cigarettes calculated using SMH method has a different ordering frequency for each raw material. The findings confirmed that the ordering frequency by SMH method is smaller than that of by the company’s method, indicating that SMH method can be further used to minimise the inventory cost paid by the company.

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