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Inventory Planning to Minimize Costs Using Silver Meal in the Indonesian Gloves Industry

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Abstract

PT XYZ is a manufacturer and distributor of gloves in Indonesia. The products produced by PT XYZ are divided into 2 types, namely synthetic and non-synthetic gloves. PT XYZ is often faced with the problem of a shortage of raw materials for Double Mesh and Merry Mesh of 14.2% and 12.5%, where the shortage of raw materials was caused by uncertain procurement of raw materials and orders. Raw materials based on historical data. The method used to solve this inventory problem is the Silver Meal method. In this study, the Silver Meal method is used to determine the optimal results to minimize the cost of ordering raw materials and obtain optimal ordering capacity to optimize inventory. The results of this study indicate that orders for Double Mesh and Merry Mesh raw materials for the next 12 months (January – December 2022) are 9 times for Double Mesh and 10 times for Merry Mesh. The Silver Meal method also provides a total cost savings of $ 32,992 or 5.85%. This study also produced a safety stock of 25 rolls for Double Mesh and 20 rolls for Merry Mesh.

Keywords: forecasting, inventory, Silver Meal, safety stock, lot size

1. Introduction

PT XYZ Indonesia is a huge manufacturer and distributor of gloves in the province of Central Java. This company is a subsidiary of PT. XYZ Indonesia as well as the company's supplier partner. The products produced by PT XYZ Indonesia are divided into 2 types, namely synthetic and non-synthetic gloves. PT XYZ Indonesia uses the Make to Order and Make to Stock systems in production activities. The make-to-stock method is applied to products that have a lot of demand in the market to meet stock (Afzalabadi, et al., 2016). Meanwhile, make-to-order is used only to produce products based on the wishes of consumers whose agreement is determined by both parties where the consumer has the right to determine specifications, types, prices, and others.

PT XYZ Indonesia is often faced with the problem of a shortage of raw materials. At the same time, the demand for certain brands has increased. A lack of raw materials will cause the production process to stop (Lai et al., 2022). This is evidenced by the cessation of the process from the cutting department due to the absence of raw materials to produce. The production process has stopped making the company have to order raw materials again (Alfares & Turnadi, 2016). Ordering raw materials back will result in large costs incurred for ordering raw materials (Alfares & Turnadi, 2016). In this case, the company will experience losses because it has to order raw materials and losses in certain costs such as electricity costs for storing raw materials and lack of consumer confidence in the company (Lukinskiy & Lukinskiy, 2017).

Based on the problems mentioned above, this research is to carry out planning for raw material inventory using the Silver Meal method. The Silver Meal method was chosen because the data on raw materials ordered were uncertain, and the purchase of raw materials back was uncertain in the same frequency (Alfares & Turnadi, 2016). The purpose of using the Silver Meal method is to obtain optimal results to minimize the cost of ordering raw materials with an uncertain

lot size (order size) each period and to determine the safety stock of raw materials to optimize inventory.

2. Methods

The steps of the research carried out are as follows

1. Aggregate demand for products.
   a) Sum the demand for each product item per period.
   b) Calculate proportions.
2. Demand forecasting.
   a) Plotting data (data pattern).
   b) Determine the appropriate forecasting method.
   c) Forecasting raw material needs.
   d) The selection of forecasting results with the smallest MAD (Mean Absolution Deviation).
3. Verification of forecasting results (Lukinskiy & Lukinskiy, 2017).
4. Determination of product raw material requirements (Afzalabadi, et al., 2016).
5. Determination of the optimal order lot using the Silver Meal method:
   a) Determination of holding cost period t (Alfares & Turnadi, 2016).
   b) Accumulated holding costs (Alfares & Turnadi, 2016).
   c) Total Relevant Cost (TRC) (Alfares & Turnadi, 2018).
   d) Calculating the average cost per time of procurement of raw materials (Ernawati et al., 2021).
   e) Order capacity using Silver Meal,
6. Calculation of safety stock of raw materials (Lauer et al., 2019).
7. Planning the number of orders for raw materials for 12 months.

3. Results and Discussion

This research was carried out at PT. XYZ Indonesia is located on Bantul, Indonesia. There are two sources of data used, namely data primary and secondary data. Primary data was collected in the form of production process data, inventory procurement system rice, and, Inventory handling systems. Secondary data was collected in the form of annual supporting data regarding rice commodities, namely rice demand data January 2020 – December 2020 period, price list for rice commodities, holding costs", ordering costs (ordering costs"), and lead time from booking. The actual data used is historical data demand for rice for the period January – December 2020. This data will be used for forecasting determination demand for rice for the next 1 year. The pattern of past demand data has a cyclical pattern, so the forecasting methods used are cyclical and exponential smoothing methods. The results of the comparison of MAD, MSE, and MAPE between the two forecasting methods can be seen in Table 1.

Table 1. Comparison of MAD, MSE, and MAPE

Metode Siklis			**Metode *Exponential Smoothing* (α = 0.9)**		
MAD	**MAP**	**MAPE**	**MAD**	**MAP**	**MAPE**
15450,2	19594156	21,1	7377,2	95289130	12,2

After the verification process, the result is that the forecasting method used is representative. The method used is the Moving Range Chart by doing a Test Out of Control. The calculations carried out at this stage aim to see the proportion of raw materials for the manufacture of Men's Performance gloves so that forecasting results are obtained based on each of the main raw materials used for the next period (January - December 2021). The results of this forecast will also be the basis of reference in calculating the size and ordering of raw materials using the Silver Meal

method. At the observation and interview stages, the daily composition in manufacturing Men's Performance gloves can be seen in Table 2. The results of the calculations of The Silver Meal Methods for Double Mesh and Merry Mesh can be seen in Table 3 and Table 4.

Table 2. The main raw material composition of gloves

Raw material		Gloves
Double Mesh	**Merry Mesh**	
0,025 m	0,02 m	1 unit

Table 3. The results of the calculations of The Silver Meal Methods for Double Mesh

Period	T	Forecast Demand (Roll)	Additional storage cost (Ph(T-1)Rt	Cumulative holding cost	TRC (T) (C+col.5)	TRC (T)/T (col.6/T)
1	1	135.7	0	0	900	900
2	2	143.9	1,438	1,438	2,338	1,169
2	1	143.9	0	0	900	900.000
3	2	133.4	1,333	1,333	2,233	1,116
3	1	133.4	0	0	900	900
4	2	102.3	1,023	1,023	1,923	961
4	1	102.3	0	0	900	900
5	2	77.9	778	778	1,678	839
6	3	81.8	1,635	2,535	3,435	1,145
6	1	81.8	0	0	900	900
7	2	91.2	912	912	1,812	906
7	1	91.2	0	0	900	900
8	2	89.4	893	893	1,793	896
9	3	94.6	1,892	2,786	4,580	1,228
9	1	94.6	0	0	900	900
10	2	88.2	881	881	1,782	891
11	3	100.5	2,010	2,891	4,673	1,264
11	1	100.5	0	0	900	900
12	2	107.7	1,077	1,077	1,977	988

Table 4. The results of the calculations of The Silver Meal Methods for Merry Mesh

Period	T	Forecast Demand (Roll)	Additional storage cost (Ph(T-1)Rt	Cumulative holding cost	TRC (T) (C+col.5)	TRC (T)/T (col.6/T)
1	1	108.6	0	0	900	900
2	2	115.1	1,467	1,467	2,367	1,183
2	1	115.1	0	0	900	900
3	2	106.7	1,360	1,360	2,260	1,130
3	1	106.7	0	0	900	900
4	2	81.9	1,043	1,043	1,943	971
4	1	81.9	0	0	900	900
5	2	62.3	794	794	1,694	847
6	3	65.4	1,668	2,568	3,468	1,156
6	1	65.4	0	0	900	900
7	2	73.0	930	930	1,830	915

Period	T	Forecast Demand (Roll)	Additional storage cost (Ph(T-1)Rt	Cumulative holding cost	TRC (T) (C+col.5)	TRC (T)/T (col.6/T)
7	1	73.0	0	0	900	900
8	2	71.5	911	911	1,811	905
8	1	71.5	0	0	900	900
9	2	75.7	965	965	1,865	932
9	1	75.7	0	0	900	900
10	2	70.6	899	899	1,799	899
11	3	80.4	2,050	2,950	3,850	1,283
11	1	80.4	0	0	900	900
12	2	86.2	1,098	1,098	1,198	999

In the sensitivity analysis, there will be an increase and decrease in two costs, namely storage costs and ordering costs (Lauer et al., 2019). For the increase and decrease in the cost of ordering will use the analysis when the ordering cost is fixed, an increase of 10%, and an increase of 20%. As for the decrease in ordering costs, we will use an analysis when the ordering costs are fixed, decreased by 10%, and decreased by 20%.

From the sensitivity analysis, it can be concluded that the decrease and increase in storage costs and ordering costs impact the value of the difference in Total Cost (TC). When the ordering cost rises from a fixed price, the difference in the Total Cost will decrease, and when the ordering cost decreases, the difference in the Total Cost will increase, and the same is true for the storage cost. This happens because in finding the Total Cost required for storage and ordering costs, there is a change in the value of the difference in Total Cost. But from each result of the difference in Total Cost obtained, the comparison of increase and decrease is not far from the fixed price because finding the difference in Total Cost also requires the amount of each raw material needed.

4. Conclusion

The Silver Meal method also provides a total cost savings of $ 32,992 or 5.85%. This study also produced a safety stock of 25 rolls for Double Mesh and 20 rolls for Merry Mesh.

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References

Afzalabadi, M., Haji, A., & Haji, R. (2016). Vendor's optimal inventory policy with dynamic and discrete demands in an infinite time horizon. *Computers and Industrial Engineering*, *102*, 368–373. https://doi.org/10.1016/j.cie.2016.06.024.

Alfares, H. K., & Turnadi, R. (2016). General Model for Single-item Lot-sizing with Multiple Suppliers, Quantity Discounts, and Backordering. *Procedia CIRP*, *56*, 199–202. https://doi.org/10.1016/j.procir.2016.10.054.

Alfares, H. K., & Turnadi, R. (2018). Lot sizing and supplier selection with multiple items, multiple periods, quantity discounts, and backordering. *Computers and Industrial Engineering*, *116*, 59–71. https://doi.org/10.1016/j.cie.2017.12.019.

Ernawati, D., Dewi, S., Sari, N. K., & Budianto, K. (2021). Ordering Size Optimization of Raw Material to Minimize Inventory Costs using Wagner-Within Algorithm and Silver-Meal Methods. *E3S Web of Conferences*, *328*, 05002. https://doi.org/10.1051/e3sconf/202132805002.

Lauer, T., Legner, S., & Henke, M. (2019). Application of machine learning on plan instability in master production planning of a semiconductor supply chain. *IFAC-PapersOnLine*, *52*(13), 1248–1253. https://doi.org/10.1016/j.ifacol.2019.11.369.

Lai, D., Li, Y., Demir, E., Dellaert, N., & van Woensel, T. (2022). Self-adaptive randomized constructive heuristics for the multi-item capacitated lot sizing problem. *Computers and Operations Research*, *147*. https://doi.org/10.1016/j.cor.2022.105928.

Lukinskiy, V., & Lukinskiy, V. (2017). Evaluation of Stock Management Strategies Reliability at Dependent Demand. *Procedia Engineering*, *178*, 53–56. https://doi.org/10.1016/j.proeng.2017.01.060.