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Managing Inventory in Response to Varying Demand at Retail Store X to Reduce Stockouts

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ABSTRACT

Both inventory shortages and excess inventory are among the issues encountered in inventory management. Lost sales are one of the impacts caused by inventory shortages. Retail Store X often experiences lost sales due to inventory shortages, such as cigarettes. Fluctuating demand and supplier terms make it difficult for this store to determine the order quantity sent to the supplier. Therefore, this research aims not only to minimize the number of stockouts but also complying with the supplier's requirement which is often disregarded in other research. The number of cigarettes that must be ordered must meet the minimum purchase under the agreed cooperation contract and the budget of Retail Store X that has been determined. This problem is solved using the periodic review system method, which relies on three parameters for the decision-making. This method calculates the order quantity for 10 cigarette products and then simulates over the next month to determine the number of stockouts that occur. Based on the results, one stockout incident was found for Tawang cigarettes amounting to two packs. Besides, the supplier requirement condition from the second supplier is also met and the purchase budget is fulfilled, which is below Rp450,000.00.

INTRODUCTION

Inventory is an important element in retail management. Things to consider in inventory include the level of consumer demand and the delivery time of goods from suppliers. The level of demand itself contains elements of uncertainty and fluctuates. Likewise, the delivery time of goods is also uncertain (Ait Mamoun et al., 2023). Both of these factors can lead to stockouts or excess inventory.

According to Sarjono (2013), stockout is a situation where a company's inventory is in shortage or certain items in the company's inventory are not available. The shortage of inventory will have a significant impact on the company, such as causing a substantial decrease in revenue, hindering the production process, resulting in lost sales, and incurring shortage costs (Vicil, 2020; Derhami & Montreuil, 2021). Therefore, good inventory management needs to be implemented.

A well-controlled inventory system will be able to assist the company in determining the order quantity of the desired products to be provided to consumers. In addition, a good inventory system can help the company implement efficiency in running its business (Fadilah et al., 2024). Through the addition of effectiveness, store owners will be able to minimize expenses adjusted to the quantity of goods ordered.

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The tobacco industry in Indonesia is one of the largest manufacturing sectors. Cigarettes make a significant contribution to the national economy as the largest contributor to Indonesia's excise tax (Prabawati & Nurhidayah, 2024). Data from the Global Adult Tobacco Survey (GATS) by the World Health Organization (2024) states that the number of smokers in Indonesia in 2021 increased by 8.8 million people compared to 2011. According to Satriawan (2022), the level of cigarette consumption in Indonesia is quite high. The high level of cigarette consumption in Indonesia encourages retailers to collaborate with suppliers to sell cigarettes in their stores. Cigarette purchases can be in the form of retail cigarettes or wholesale purchases. Based on data from the Center for Indonesia's Strategic Development Initiatives (2023), 85% of street vendors and small shops in Indonesia sell cigarettes in retail.

Retail store X in Banjarnegara, Central Java is a retail business that sells essential goods. In addition, the store also sells cigarettes. The X Store has not yet implemented data analysis to determine the quantity of orders to suppliers because there is no historical data recording of the items. Ordering goods from suppliers is done manually, relying on personal opinions based on past experiences. However, mistakes often occur in estimating the quantity of goods that need to be ordered. This results in Store X frequently experiencing stockouts.The object of the research to be studied is cigarette products at Store X. In determining the order of cigarettes to the supplier, the store only takes a quick glance at the storage area, resulting in inaccurate order quantities and often causing unexpected stockouts.

Based on previous research, there is a similar problem, namely stockouts of inventory items. The shortage of inventory labels (cigarette packs) caused by production defects is experienced by the cigarette company. This company also strives to calculate inventory needs using periodic review, where production is carried out at fixed intervals (Handoko, 2021). Running out of raw materials was also experienced by the Grand Kartika restaurant, which caused the restaurant to be unable to fulfill customer orders. Therefore, Laoli et al. (2022) conducted raw material ordering calculations using the economic order quantity (EOQ) method. A similar occurrence is experienced by the meatball industry, which also calculates the ordering of beef raw materials using EOQ (Supriyadi & Nurdewanti, 2022), and the garment industry, specifically for ordering twill fabric using EOQ and POQ (Nuffus, 2021). The three studies above only handle inventory for single products with the assumption that demand tends to be constant. Setiawan and Puspitasari (2022) and Suyono et al. (2018) subsequently worked on multi-product, but the demand still tends to be constant using the EOQ and POQ methods. On the other hand, Ratnawia et al. (2019) conducted research on a single product only, but the demand tends to be fluctuating using the periodic review (R, s, S) system.

In fact, an industry does not only have a single product, but also it has several products, and demand tends to fluctuate. Diantono (2022), Angelica (2022), Syamil et al. (2018), Regina (2020), and Sari et al. (2016) consider both aspects, namely multi-product and fluctuating or probabilistic demand. A qualitative approach was used to analyze the factors that can be utilized for merchandise control in several Alfamart stores in the South Jakarta area (Regina, 2020). However, this approach does not use numerical data in its analysis. Unlike the other four studies that use a quantitative approach. The continuous review method, Hadley-Whittin inventory model, is used to anticipate fluctuating demand (Diantono, 2022; Angelica, 2022). Another continuous method, the (s, S) system, is used to anticipate lost sales (Sari et al., 2016; Syamil et al., 2018), as well as the (s, Q) system (Syamil et al., 2018).

This research adopts the periodic review model instead of the continuous review model because it is more suitable for the situation at Store X. Store X places orders periodically at certain intervals. The periodic review model used is the (R, s, S) system. The final result or output of this research is not only the calculation of the proposed quantity of cigarettes to be ordered from the supplier but also the ratio distribution of the proposed order quantity for both suppliers. The ordering terms from the supplier, which are considered in determining the order quantity, in addition to the costs incurred that were not found in previous studies. Therefore, the objective of this research is to minimize the occurrence of cigarette stockouts at Store X by assisting the store

in determining the appropriate order quantity in accordance with the existing inventory while considering the supplier's requirements.

RESEARCH METHODS

Periodic review (R, s, S) has three parameters in decision-making. The three parameters are the review interval (R) parameters, reoder point (s), and maximum inventory level (S). The inventory will be checked whether the inventory is still in a safe level or not every R unit of time. Inventories are still at a safe level when the amount is above the reorder point(s). Therefore, ordering from suppliers does not need to be done until the next inventory review. Conversely, the supply is in an unsafe level when the amount is below the reorder point(s). If in such conditions, food will be ordered to the supplier according to the required amount up to the maximum value of the inventory of goods (S). The assumption of data used in this method is normal distribution. (Silver et al., 2016).

The effectiveness and accuracy of the inventory management model used are influenced by the alignment of the data distribution with the normal distribution. The normality test using the Kolmogorov-Smirnov test is necessary to ensure that the assumption of normal distribution for demand or lead time in the (R, s, S) model is valid with the existing data (Turrini & Meissner, 2019; Djohan & Stefvy, 2023).

Here are the steps in the periodic review (R, s, S) system method. The numbers in this formula are the result of the power approximation calculations conducted by Ehrhardt (1979), then updated by Ehrhardt and Moiser (1984), and further developed by Naddor (1975). Zheng and Federugen (1991) further developed it to find the optimal values of s and S by considering the value of R and the demand distribution.

1. Calculating the parameters Q_p and S_p.

$$Q_p = 1.30\bar{x}R^{0,494}\left(\frac{A}{vr}\right)^{0.506}\left(1+\frac{(\sigma_R+L)^2}{\bar{x}R}\right)^{0.116}$$

$$s_p = 0.973\bar{x}_{R+L} + \sigma_{R+L}\left(\frac{0.183}{z} + 1.063 - 2.192z\right)$$

where,

$$z = \sqrt{\frac{Q_p \times r}{\sigma_{R+L} \times B_3}}$$

$$\bar{x}R = D \times R$$

$$\bar{x}_{R+L} = D \times (R+L)$$

2. If $\frac{Q_p}{\bar{x}R} > 1.5$, then:

$$s = s_p$$

$$S = s_p + Q_p$$

3. If $\frac{Q_p}{\bar{x}R} < 1.5$, then:

$$S_0 = \bar{x}_{R+L} + k\sigma_{R+L}$$

where,

$$p_\mu \geq (k) = \frac{r}{B_3 + r}$$

Then, the values of parameters s and S can be calculated as follows:

$$s = minimum\{s_p, S_0\}$$

$$S = minimum\{s_p + Q_p, S_0\}$$

Notation explanation:

D : average monthly demand (packs/month)

Q_p : number of orders per order cycle (packs)

s_p : reorder point (packs)

$\bar{x}R$: reorder quantity (packs)

$\bar{x}_{R+L}$: average inventory during the interval review (packs/month)

L : lead time (month)

z : parameter used to calculate the optimal value

A : order cost (Rp/order)

r : holding cost (Rp/packs/month)

B_3 : shortage cost (Rp/packs)

v : selling price (Rp/packs)

R : interval review (month)

p_μ : probability of demand per unit time

k : factor at the upper limit S_0

S_0 : upper limit value for S (packs)

S : maximum inventory level (packs)

s : *reorder point* (packs)

RESULTS AND DISCUSSION

Toserba X is a local retail store that sells a variety of daily necessities, such as food and beverages, electrical appliances, children's toys, cigarettes, cooking oil, and more. Toserba X is located in Banjarnegara Regency, Central Java, operating from 08:00 AM to 10:00 PM. This store has been established since 1970.

Toserba X still implements a manual buying and selling system, does not yet have a system for recording item history data, and still places orders relying on intuition. Ordering errors often occur due to human error in estimating the quantity of goods to be ordered. The store staff only takes a quick glance at the storage area before determining the order quantity to the supplier. As a result, the store often experiences unexpected stockouts. Based on an interview with the store owner, Toserba X often experiences stockouts once customers place their orders. If that event happens repeatedly, consumers will go shopping at other retail stores, leading to lost sales. The product in question is cigarettes.

Demand for Cigarettes

Cigarette products contribute 30 – 40% of the total revenue of Toserba X. The selling price ranges from Rp 7,000.00 to Rp 37,000.00. The number of suppliers for the cigarette product was initially three suppliers. However, there was an internal issue with one of the suppliers, reducing the number of suppliers to just two, namely supplier MR and DRP. Among the two suppliers, supplier MR is able to supply most of the goods to Toserba X at a more affordable price and with a greater variety of products compared to supplier DRP. Additionally, supplier MR offers flexibility in the settlement (payment) of goods by providing a one-week payment term, whereas supplier DRP requires the store to make direct cash payments. Toserba X continues to cooperate with supplier DRP because the store has made a contractual agreement with DRP, which consequently requires Toserba X to order cigarette products supplied by DRP, specifically Djarum brand cigarettes.

The demand data from September 2022 to March 2023 was used in this study. Ten SKUs will undergo additional analysis. The ten SKUs are classified as fast-moving items. A data normalcy test will be used to determine whether or not these goods have a normal distribution. Minitab 18 program is used to test the distribution data using the Kolmogorov-Smirnov test. If the probability value (p-value) is greater than zero, the data will be regarded as normal. If not, the information is regarded as non-normal (Nuryadi et al., 2017). The data from the Kolmogorov-Smirnov test distribution is summarised in the Table 1.

Tabel 1. Summary of the Kolmogorov-Smirnov Test Distribution

SKU	Mean	N	Results	p-value	Conclusion of p-value
Djarum 76 12’	216.7	7	0.226	> 0.150	> 0.05, normal data
Sampoerna Mild 16’	214.9	7	0.244	> 0.151	> 0.05, normal data
Djarum Super 12’	156.1	7	0.346	0.015	> 0.05, normal data
GG. Surya 16’	149.1	7	0.268	0.130	> 0.05, normal data
GG. Filter	101.9	7	0.183	> 0.150	> 0.05, normal data
Marlboro Merah	67.1	7	0.177	> 0.150	> 0.05, normal data
Djarum La Bold 20’	66.7	7	0.212	> 0.150	> 0.05, normal data
Tawang	62.3	7	0.259	> 0.150	> 0.05, normal data
GG. Signature Hitam	57	7	0.281	0.092	> 0.05, normal data
Sampoerna Kretek	55.3	7	0.200	> 0.150	> 0.05, normal data

After the demand data is analyzed for its distribution type, the next step is to identify holding costs, ordering costs, shortage costs, and lead time. The holding cost (Rp/package/month) uses a BI rate of 5.5%, while the ordering cost (Rp/order) is Rp 21/order. As mentioned earlier, this convenience store is experiencing lost sales because it cannot meet consumer demand. Therefore, the shortage cost (Rp/pack) is calculated from the price difference between the purchase price of cigarettes from the supplier and the selling price of those cigarettes at Toserba X. The lead time for supplier MR and DRP is the same, which is 6 days.

Analysis of Calculations Using the Periodic Review R, s, S Model

The Periodic Review Inventory Model R, s, S assumes that the data is normally distributed, lead time is constant, and product demand is not constant. This research will use equations xx to yy for the ten selected cigarette products. Here is a sample calculation for the Djarum 76 12' product.

1. Calculating the parameters of Q_p and S_p.
   Before performing the calculations of Q_p and s_p, the values of $\bar{x}R$ and $\bar{x}_{R+L}$ need to be calculated first.
   $\bar{x}R = 217 \times 0{,}23 = 50{,}57$
   $\bar{x}_{R+L} = 217 \times (0{,}20 + 0{,}23) = 93{,}91$
   $Q_p = 1{,}30 \times (50{,}57)^{0{,}494} \times \left(\frac{21}{15000 \times 61}\right)^{0{,}506} \times \left(1 + \frac{20{,}89^2}{50{,}57}\right)^{0{,}116} = 3$ packs, with z-value:
   $z = \sqrt{\frac{3 \times 61}{20{,}89 \times 1781}} = 0{,}08$
   Hence, the value of s_p
   $s_p = (0{,}973 \times 93{,}91) + \left(19{,}40 \times \left(\frac{0{,}183}{0{,}08}\right) + 1{,}063 - (2{,}192 \times 0{,}08)\right) = 155$ packs

2. Checking the value of $\frac{Q_p}{\bar{x}R}$.
   $\frac{Q_p}{\bar{x}R} = \frac{3}{50{,}57} = 0{,}07 < 1{,}5$
3. If $\frac{Q_p}{\bar{x}R} < 1{,}5$, then:

$p_\mu \geq (k) = \frac{61}{1781+61} \approx 0{,}03$

$S_0 = 93{,}91 + (0{,}03 \times 19{,}40) = 94{,}56 \text{ packs} \approx 95 \text{ packs}$

Based on the calculations above, it is known that the minimum stock quantity is 95 packs, as well as the maximum stock quantity for the Djarum 76 12' product. In other words, when the stock in the warehouse falls below 95 packs, the store can perform replenishment until the inventory reaches a maximum of 95 packs. Here is the summary table 2 of results for all products.

Tabel 2. The results of Periodic Review R, s, S model

	Djarum 76 12'	Djarum LA Bold Hitam 20'	Djarum Super 12'	GG Filter 12'	GG Signature Hitam
L	0.20	0.20	0.20	0.20	0.20
B_3	1781	1975	2169	1875	1700
R	0.23	0.23	0.23	0.23	0.23
r (Rp)	61	132	101	102	92
$\bar{x}R$	50.57	15.57	36.43	23.77	13.30
$\bar{x}R + L$	93.91	28.91	67.66	44.14	24.70
$\sigma R + L$	19.40	14.22	17.24	10.40	5.15
Q_p	3	2	3	2	2
Z	0.24	0.10	0.09	0.11	0.13
S_p	155	67	116	69	35
$Q_p/X_r > 1.5$	0.07	0.13	0.08	0.10	0.12
$p_\mu(k)$	0.03	0.06	0.04	0.05	0.05
S_0	101.83	32.10	73.69	48.11	26.89
s	95	30	69	45	25
S	95	30	69	45	25

Tabel 2. (Continued)

	GG Surya 16'	Marlboro Merah	Sampoerna Kretek	Sampoerna Mild Merah 16'	Tawang
L	0.20	0.20	0.20	0.20	0.20
B_3	1550	1715	1688	2495	1925
R	0.23	0.23	0.23	0.23	0.23
r (Rp)	136	162	62	133	39
$\bar{x}R$	34.80	15.67	12.90	50.13	14.53
$\bar{x}R + L$	64.63	29.10	23.96	93.10	26.99
$\sigma R + L$	13.75	7.84	8.33	20.84	15.20
Q_p	3	2	2	3	2
Z	0.13	0.15	0.09	0.09	0.05
S_p	92	44	48	149	96
$Q_p/X_r > 1.5$	0.08	0.12	0.13	0.07	0.13
$p_\mu(k)$	0.08	0.09	0.04	0.05	0.02
S_0	70.79	32.06	26.12	101.40	29.39
s	66	30	25	95	27
S	66	30	25	95	27

Inventory Simulation

The implementation plan will be applied using a simulation for one month, namely April 2023. Ordering in the simulation will be conducted using the order results calculated with the Periodic Review R, s, S System method.

Determination of product demand in the simulation uses random numbers with the function f(x) = randbetween(0,100). In the process, a calculation of the probability of product demand is also carried out based on sales data from September 2022 to March 2023.

The ending inventory will be obtained by subtracting the daily demand from the previous day's inventory according to the data obtained in the simulation. Through the final inventory, stockout occurrences can be observed.

Based on the results of observations and interviews with stakeholders, the main issue to be resolved is the frequent occurrence of stockouts that result in lost sales. Therefore, inventory simulation needs to be conducted using the results of the Periodic Review R,s,S System method calculations. This simulation is conducted to prove that with the recommendation of ordering goods using the Periodic Review R,s,S System method, stockout incidents at Toserba X can be minimized. The simulation was conducted by reviewing the movement of inventory and the final inventory level of cigarettes at Toserba X based on the sales of 10 cigarette products from September 2022 to March 2023. Then the data will be simulated for one month ahead, namely the month of April 2023. Here is Figure 1 regarding the inventory simulation used.

				1	2	3	4	5	6	7
S		Permintaan (pak)								
s		Persediaan Area Simpan (pak)								
L		Kekurangan (pak)								
		Diterima (pak)								
		Pemesanan (pak)								
		Biaya Simpan (Rp/pak/bulan)								
		Biaya Pesan (Rp/order)								
		Total Biaya (Rp)								

Figure 1. An Inventory Simulation for April 2023

The first row is filled in with the name of the cigarette SKU that will be simulated. The second row is the projected month period in the simulation. The third row contains the period of days, which in this case are the days or dates in April 2023. On the left side, there are the following notations: maximum inventory (S), reorder point (s), and lead time (L). In the row "Demand (packs)" is the row that contains the demand data that has been carried out and constructed using Monte Carlo simulation. In the line "Storage Area Inventory (pack)" is the line to determine the amount of product inventory at the end of the period. In the line "Shortage (packs)," it is the number of stockouts that occurred during that period. In the "Received (pack)" row, it is the row when the cigarettes ordered from the supplier have been received by the store. Storage costs are obtained through the expenses incurred by the store to store the goods in the existing storage area. The ordering cost is obtained through the total cost incurred when the store orders goods from the supplier, while the total cost is the sum of the holding cost and the ordering cost. Figure 2 is an example simulation of Djarum 76 12' cigarette product, and Table 3 is a summary of the inventory simulation results for the ten cigarette products.

				1	2	3	4	5	6	7
S	95	Permintaan (pak)	0	4	8	5	7	4	9	1
s	95	Persediaan Area Simpan (pak)	41	37	29	24	17	13	4	61
L	6	Kekurangan (pak)		0	0	0	0	0	0	0
		Diterima (pak)		0	0	0	0	0	0	58
		Pemesanan (pak)		58						
		Biaya Simpan (Rp/pak/bulan)		76	59	49	35	27	8	125
		Biaya Pesan (Rp/order)		21	0	0	0	0	0	0
		Total Biaya (Rp)		97	59	49	35	27	8	125

Figure 2. An Example Simulation of Djarum 76 12’

Tabel 3. The results of Periodic Review R, s, S model

SKU	On-hand inventory	Stockout quantity	The proposed order quantity	The proposed order quantity per supplier		The total costs	
				Supplier 1	Supplier 2	Supplier 1	Supplier 2
Djarum 76 12’	41	0	95	84	11	1,119,332.00	153,095.00
Djarum LA Bold Hitam 20’	18	0	30	28	2	819,789.00	47,129.00
Djarum Super 12’	51	0	69	64	5	1,410,894.00	110,305.00
GG Filter 12’	57	0	45	45	-	1,005,750.00	-
GG Signature Hitam	22	0	25	25	-	502,500.00	-
GG Surya 16’	41	0	66	66	-	1,953,600.00	-
Marlboro Merah	39	0	30	30	-	1,058,100.00	-
Sampoerna Kretek	18	0	25	25	-	336,875.00	-
Sampoerna Mild Merah 16’	41	0	95	95	-	2,758,800.00	-
Tawang	41	2	27	27	-	231,981.00	-
Total costs per supplier						11,197,621.00	310,529.00
Total costs							

Based on the calculations using the periodic review R, s, S system method, the results show the order quantity of products for retail store X for both suppliers. However, there is a cost limit imposed by Store X for purchases from the second supplier, which is Rp450,000.00. In addition, the cigarette orders from the second supplier are only for Djarum brand cigarettes. Therefore, the proposed order quantity also considers the sales proportion of that cigarette brand. The proposed order quantity for the first supplier with a retail type is 84 packs of Djarum 76 12', 28 packs of Djarum LA Bold Black 20', 64 packs of Djarum Super 12', 45 packs of GG. Filter 12', 25 packs of GG. Signature Black, 66 packs of GG. Surya 16', 30 packs of Marlboro Red, 25 packs of Sampoerna Kretek, 95 packs of Sampoerna Mild Red 16', and 27 packs of Tawang. The proposed quantity of cigarette orders for the second supplier with retail type is 11 packs of Djarum 76 12’, 2 packs of Djarum LA Bold Hitam 20’, and 5 packs of Djarum Super 12’. The retail order quantity for supplier 2 is based on the cost limitation of retail store X amounting to Rp 450,000.00, so the order quantity is determined by considering the sales proportion of their Djarum products.

CONCLUSION

The researcher assisted in determining the order amount utilising the Periodic Review R,s,S System calculating method in an effort to lessen the problem of cigarette stockouts at retail store X. The store was provided the suggested number of cigarette orders to place with two vendors for both retail and wholesale cigarette products. There were only two instances of stockouts in the retail sale of Tawang brand cigarettes, according to the simulation run at store X. Furthermore, the second supplier's order of cigarettes cost only Rp310,529, which is within the established cost limit of Rp450,000.

The recording of historical data on demand and stockouts will be more optimal if done continuously. Well-documented historical data will greatly assist the store in determining the

cigarette ordering policy with the supplier. To ensure accurate stock monitoring and ordering calculations in line with current conditions, the store needs to regularly update the data in the Excel file and store purchase receipts, both from supplier 1 and supplier 2, in an organized and systematic manner.

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