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Case Study

Inventory Planning of Raw Materials for Furniture Products (Case Study: CV XYZ Furniture)

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A B T R A C T

The burgeoning industrial sector in Indonesia has intensified competition among businesses vying for market share. The furniture industry is a prime example of this dynamic landscape. To expand their market reach, companies must demonstrate their ability to fulfill every consumer demand. Failure to meet these expectations will prompt consumers to seek alternatives. One crucial factor in meeting consumer demands is product availability, which is directly influenced by the availability of raw materials within the company. CV XYZ Furniture, a furniture company based in Padang City, exemplifies this challenge. The company produces a diverse range of furniture, primarily utilizing rattan as its raw material. However, CV XYZ Furniture currently lacks a structured inventory planning method for raw materials, resulting in excess inventory for each period. To address this issue, this research aims to establish an optimized inventory planning strategy for raw materials used in furniture production at CV XYZ Furniture. The continuous review system method serves as the foundation for this endeavor. The research outcomes encompass the determination of optimal demand quantity, reorder point, and safety stock. The implementation of the continuous review system model yielded a significant reduction in total inventory costs, amounting to Rp8,625,594 or 2.03%. It can be proven that the continuous review system model is suitable for calculating raw material inventory at CV XYZ Furniture for raw material planning in the following years.

INTRODUCTION

The Indonesian industrial sector is characterized by an intensifying competitive environment, where businesses of all sizes vie for market share. Customer satisfaction stands as a key differentiator in this dynamic landscape, with companies striving to meet and exceed customer demands. One crucial factor in achieving customer satisfaction is the ability to fulfil customer orders promptly and efficiently. To achieve this, companies must implement effective inventory management systems for raw materials, ensuring a smooth and uninterrupted production process. Inventory, as defined by Bahagia (2006), represents idle resources awaiting further processing, such as production activities in manufacturing systems, marketing activities in distribution systems, or food consumption activities in household systems. Yafia et al. (2023) further emphasize the fluidity of inventory as an asset that continuously circulates, contrasting it with other fixed assets.

Issues arising from inaccurate inventory determination include stockouts and overstocks (Mweshi, 2022). Excess raw material inventory in any given period can be considered waste due to the embedded costs associated with the excess inventory and the unhealthy cash flow of the company as a result of a large amount of company money being tied up in inventory in the form of raw materials (Ledy Vanesa & Helma, 2023). On the other hand, if a stockout occurs, the company experiences losses due to customer loss, inability to meet customer demand, production delays, missed due dates, and increased ordering costs. Therefore, inventory management is a very important issue for companies, especially those in the manufacturing sector. The objective of inventory planning is to have the right amount of goods in the right place at the right time and at a relatively low cost (Sri, 2021).

Previous studies have addressed various aspects of inventory management. For example, Saputra et al. (2021)

discussed the importance of determining purchase frequency, timing, and quantity, as well as maintaining safety stock to avoid production delays. Einjelica By & Yamit (2022) emphasized the need for accurate data on product demand, raw material ordering costs, and purchase prices for effective inventory planning. Dendra et al. (2023) highlighted the challenges in determining order quantities, reorder points, and maintaining adequate inventory to address fluctuating demand.

CV XYZ Furniture, a manufacturing company in the furniture industry, produces various types of furniture products, including rattan guest chairs, terrace chairs, dining chairs, swings, children's chairs for motorbike seats, and food covers. According to interviews with the owner and one of the employees, it was revealed that the purchase of raw materials does not require a minimum order and does not receive discounts for bulk purchases. CV XYZ Furniture experiences inconsistent sales each month. This inconsistency poses a challenge for the company in determining the optimal inventory level to meet fluctuating customer demand. The company currently lacks a basis for determining the quantity and timing of orders. Additionally, the company does not maintain a reserve of raw material inventory as an alternative when supplies run out.

The products with the highest sales at CV XYZ Furniture are children's chairs for motorbike seats, food covers, and swings. To meet this high sales volume, CV XYZ Furniture must effectively plan the raw material inventory used to support the production process. Without proper inventory planning, the production process can be disrupted (Fithri et al., 2019). If the production process is not smooth, the company will not be able to meet consumer demand (Zacharias, 2022).

At CV XYZ Furniture, there was an excess of raw material inventory every month in 2022. The largest contributors to this overstock were synthetic plastic raw materials at 20% and manau raw materials at 19%. This excess inventory was due to inaccurate determination of inventory levels, resulting in significant costs for CV XYZ Furniture. Proper and efficient inventory planning is necessary to ensure a smooth production process and to prevent high capital investment in raw material inventory. Therefore, in raw material inventory planning, it is crucial to determine the purchase frequency within a given period, the timing of purchases, the quantity of raw materials to be purchased each time, and the minimum number of raw materials to be maintained as safety stock to avoid production delays (Saputra et al., 2021).

The primary objective of this research is to develop a comprehensive inventory management strategy for CV XYZ Furniture to optimize raw material inventory levels. This includes determining the optimal order quantities and reorder points for raw materials, establishing safety stock levels to prevent production delays, and reducing excess inventory to minimize associated costs and improve cash flow. Additionally, the research aims to enhance the overall efficiency of the production process to meet fluctuating customer demand. This study contributes to the existing literature by addressing the classic problem of inventory management in the context of inconsistent sales and demand fluctuations. While previous studies have explored various inventory management strategies, this research provides practical solutions tailored to the specific challenges faced by CV XYZ Furniture, offering insights that can be applied to similar manufacturing companies. By focusing on the unique conditions of CV XYZ Furniture, the research offers a case-specific approach that highlights the importance of customized inventory management strategies in achieving operational efficiency and customer satisfaction.

METHOD

This study employs ABC analysis to categorize raw materials for furniture products. ABC analysis is used to group raw material types based on the level of investment absorbed in providing inventory for each type of raw material (Puspasari & Rusli, 2023). The reason for using the ABC analysis method is to facilitate the classification of furniture product raw materials (Czerniachowska et al., 2023). The advantage of classifying these raw materials is that it allows for inventory planning for each category, thereby increasing efficiency and reducing inventory costs (Nugraha et al., 2016).

Inventory planning methods consist of deterministic and probabilistic methods (Rizqi & Khairunisa, 2020). Deterministic methods are inventory models in which all parameters are known with certainty (Munyaka & Yadavalli, 2022). Deterministic models can be static, where the ordering quantity is fixed for a single instance, and inventory remains constant or limited within a certain period (William et al., 2020). Deterministic models can also be dynamic, where demand is known with certainty but varies from one period to the next (Pardede & Vanany, 2021). Probabilistic inventory models, on the other hand, deal with phenomena that are not known with certainty, but their expected values, variances, and probability distributions can be predicted (Maertens et al., 2022). Probabilistic inventory models have the characteristic of uncertain demand (Silitonga et al., 2021).

The demand pattern for each type of raw material at CV XYZ Furniture is probabilistic, hence the inventory method used in this study is a probabilistic inventory

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method. Probabilistic inventory methods include the P model and the Q model (Bahagia, 2006). The P model is an inventory control system where the time intervals between orders are fixed, but the order quantity varies (Kurniawan et al., 2022). In contrast, the Q model is an inventory control system where the order intervals vary, but the order quantity is fixed (Kurniawan et al., 2022). The continuous review system, a part of the Q model, is used for inventory planning in this study because it minimizes the likelihood of stockouts, which can occur only during the lead time. In contrast, stockouts in the P model can occur during both the lead time and the period between orders.

The ordering costs for raw materials at CV XYZ Furniture are constant for each order. Raw material inventory at CV XYZ Furniture is continuously reviewed by the company's employees. This aligns with the characteristics of the continuous review system.

This research systematically applies ABC analysis and probabilistic inventory methods to optimize raw material inventory at CV XYZ Furniture.

1. ABC Analysis:
   a. Categorize raw materials into three classes (A, B, and C) based on their investment value.
   b. Class A represents the highest investment and requires the most rigorous control. Class B represents moderate investment, and Class C represents the lowest investment.
2. Inventory Method Selection:
   a. For Class A raw materials, the continuous review (s,S) system is used. This involves:
      - Setting a reorder point (s) and a maximum inventory level (S).
      - Placing orders up to the maximum inventory level when the inventory level drops to or below the reorder point.
   b. For Class B and C raw materials, the continuous review (s,Q) system is employed. This involves:
      - Setting a reorder point (s) and a fixed order quantity (Q).
      - Placing a fixed quantity order when the inventory level drops to or below the reorder point.
3. Data Collection:
   a. Gather raw material requirement data for the year 2022.
   b. Collect data on raw material costs, ordering costs, holding costs, stockout costs, lead times, and demand variability.
4. Formulation:
   a. Calculate the initial order quantity and reorder point using established inventory management formulas.
   b. Use probabilistic models to determine the optimal safety stock level and total inventory costs.
5. Implementation:
   a. Apply the continuous review (s,S) system for Class A raw materials and the continuous review (s,Q) system for Class B and C raw materials.
   b. Regularly review and adjust inventory levels based on actual demand patterns and variability.

By following these steps, this research aims to provide a systematic approach to inventory management that reduces costs and improves efficiency at CV XYZ Furniture. The detailed calculation results and their analysis will be presented in the results and discussion section.

RESULT AND DISCUSSION

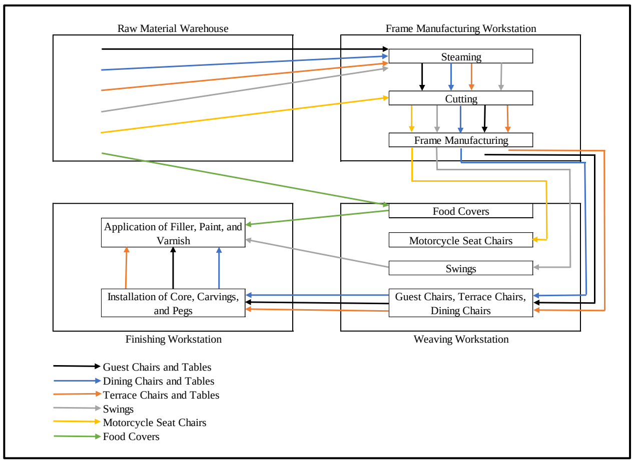

Fig. 1. Production Process Flow

The production process flow for each furniture product at CV XYZ Furniture begins from the raw material warehouse. The production processes for the swing, guest chairs and tables, dining chairs and tables, and terrace chairs and tables are identical. The production process for these four products starts with the fabrication of chair and table frames and swing frames using manau raw materials at the frame fabrication workstation. At this workstation, three production processes are carried out: steaming to bend the manau for shaping into chair and table frames. Subsequently, the steamed manau is cut to size according to the dimensions of each type of chair, table, and swing. Afterward, frame fabrication takes place.

After the frame fabrication is completed, each type of chair and table is immediately taken to the next workstation, namely the weaving station. At this workstation, only one production process is carried out: weaving the chairs, tables, and swing frames using rattan raw materials. Subsequently, the chairs and tables are transferred to the final assembly workstation for crossbar installation, carving, and dowel insertion, while the swing frames are directly moved to the painting and varnishing process.

Finally, the chairs and tables are painted and varnished to enhance the product's quality. After everything is completed, the products are transferred and stored in the finished product warehouse.

The production process flow for motorcycle seat chairs begins from the raw material warehouse and enters the frame fabrication workstation. Since the motorcycle seat chair frame uses medium-sized rattan, the process proceeds directly to cutting and then frame fabrication. Subsequently, the frame is taken to the weaving station to be woven using synthetic plastic raw materials. Once the weaving is complete, the motorcycle seat chair is directly transported to the finished product warehouse and does not require painting because the synthetic plastic material is already colored.

The production process flow for food covers starts from the raw material warehouse and goes directly to the weaving station because this product does not use frames made of medium-sized rattan or manau. Food covers are woven directly using rattan raw materials. Afterward, the food covers are transferred to the final assembly workstation for painting and varnishing. Then, the products are moved to the finished product warehouse.

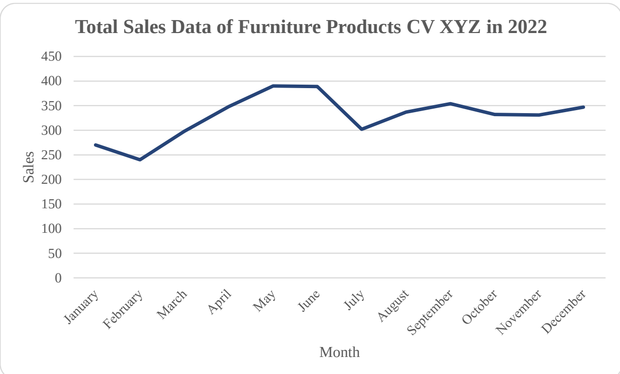

Fig. 2. Total Sales Data of Furniture Products CV XYZ in 2022

The data used for raw material inventory planning is the raw material requirement data for the year 2022. Demand is treated as an input with a probabilistic pattern. Historical data patterns for raw materials from the previous years were analyzed using time-series analysis and forecasting models to predict the annual demand. This involves collecting historical demand data, identifying trends, and applying statistical forecasting methods to predict future demand. Below is an example calculation of inventory planning for one of the raw materials classified as A, namely manau, using the continuous review (s,S) system model.

Raw material required (D)	: 8670 poles
Cost of raw material	: Rp15.000/poles
Purchase cost	: Rp130.050.000
Ordering cost (A)	: Rp18.442
Holding cost (h)	: Rp8.910
Stockout cost (Cu)	: Rp15.000
Lead time	: 0,002778 years
Standard deviation	: 378,61

The stages in conducting raw material inventory planning for furniture products at CV XYZ Furniture are as follows:

a. Calculation of the optimal order quantity and reorder point inventory level. The formulas used in the calculations are as follows:

1. Calculate the initial order quantity q_{01}^* equal to the replenishment order quantity q_{0w}^* using Wilson formula.

$$q_{01}^*=q_{0w}^*=\sqrt{\frac{2.A.D}{h}} \quad (1)$$

$$q_{01}^*=q_{0w}^*=\sqrt{\frac{2 \text{ x Rp}18.442 \text{ x } 8670}{\text{Rp}8.910}} \quad (2)$$

$$q_{01}^*= 189,44 \quad (3)$$

2. Based on the obtained value of q_0^*, the probability of inventory shortage (α) can be determined, which will then allow the calculation of the optimal reorder point r_1^* using the equation:

$$\alpha = \frac{h.q_{01}^*}{C_u.D} \quad (4)$$

$$\alpha = \frac{\text{Rp}8.910 \text{ x } 190}{\text{Rp}15.000 \text{ x } 8670} \quad (5)$$

$$\alpha = 0,0129 \quad (6)$$

The value of Z_α can be obtained through the Standard Normal Table A. Subsequently, the optimal reorder point r_1^* can be calculated using the following equation:

$$r_1^*=D.L+Z_\alpha\sqrt{L} \quad (7)$$

$$r_1^*= 8670 \text{ x } 0,00278 + 2,22 \text{ x } 378,6 \text{ x } \sqrt{0,002278} \quad (8)$$

$$r_1^*= 68,519 \quad (9)$$

3. Based on the obtained equation for r_1^* the value of q_{02}^* can be calculated using the following formula:

$$q_{02}^*=\sqrt{\frac{2.D(A+C_u \int_{r_1^*}^{\infty}(x-r_1^*)f(x)dx)}{h}} \quad (10)$$

$$\int_{r_1^*}^{\infty}(x-r_1^*)f(x)dx=SL[f(Z_\alpha)-Z_\alpha\psi(Z_\alpha)]=N \quad (11)$$

$$N = SL[f(Z_\alpha)-Z_\alpha\psi(Z_\alpha)] \quad (12)$$

$$N = 378,61 \text{ x } 0,0022 \; [0,033 - (2,22 \text{ x } 0,0045)] \quad (13)$$

$$N = 0,0245 \quad (14)$$

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$$q_{02}^{*}=\sqrt{\frac{2 \times 8670\ (Rp18.442 + Rp15.000 \times 0{,}0245}{Rp8.910}} \quad (15)$$

$$q_{02}^{*}= 191{,}33 \approx 192 \text{ poles} \quad (16)$$

The values of $f(Z_\alpha)$ and $\psi(Z_\alpha)$ can be obtained from Table B. Subsequently, the values of α and r_2^* can be calculated using the following equations:

$$\alpha=\frac{h.q_{02}}{C_u.D} \quad (17)$$

$$\alpha=\frac{Rp8.910 \times 191{,}33}{Rp15.000 \times 8670} \quad (18)$$

$$\alpha=0{,}0131 \quad (19)$$

$$r_2^*=D.L+Z_\alpha \times S\sqrt{L} \quad (20)$$

$$r_2^*= 8670 \times 0{,}0022 + 2{,}22 \times 378{,}61 \times \sqrt{0{,}00227} \quad (21)$$

$$r_2^*= 68{,}442 \approx 69 \text{ poles} \quad (22)$$

Next, a comparison is made between the values r_1^* and r_2^*, if the value of r_2^* is relatively similar to r_1^* then the iteration is completed, and $r^* = r_2^*$ and $q_0^*=q_{02}^*$ are obtained. If not, then return to step 3 by replacing the values of $r_1^* = r_2^*$ and $q_{01}^*=q_{02}^*$.

b. Calculation of the optimal safety stock quantity

The safety stock calculation accounts for the uncertainty in demand, with the unit specified as poles. The Zα value, representing the number of standard deviations required to meet a specific service level, is derived from the standard normal distribution table, ensuring a 95% service level corresponding to Zα ≈ 2.22. Lead time in this study is considered constant based on historical data from supplier performance, ensuring reliable inventory replenishment. The formula used is as follows:

$$SS = Z_\alpha+S\sqrt{L} \quad (23)$$

$$2{,}22 + 15\sqrt{0{,}00227} \quad (24)$$

$$SS = 3{,}02 \approx 4 \text{ poles} \quad (25)$$

c. Calculation of total inventory costs

The formula used is as follows:

1. Purchase cost (O_b)

$$O_b = D \times p \quad (26)$$

$$O_b = 8670 \times Rp15.000 \quad (27)$$

$$O_b = Rp130.050.000 \quad (28)$$

2. Procurement cost (O_p)

$$O_p = \frac{AD}{q_0} \quad (29)$$

$$O_p = \frac{Rp18.442 \times 8670}{192} \quad (30)$$

$$O_p = Rp848.332 \quad (31)$$

3. Holding cost (O_s)

$$O_s =(\frac{1}{2}q_0+s) \times h \quad (32)$$

$$O_s = (\frac{1}{2}190 + 26 - (8670 \times 0{,}00227)) \times Rp8.910 \quad (33)$$

$$O_s = Rp1.254.825 \quad (34)$$

4. Shortage cost (O_k)

$$O_k= \frac{C_u.D}{q_0}\int_r^\infty (x-r)f(x)dx \quad (35)$$

$$O_k= \frac{Rp15.000 \times 8670}{192} \times 0{,}0245 \quad (36)$$

$$O_k= Rp16.717 \quad (37)$$

5. Total inventory cost (O_T)

$$O_T = O_b + O_p + O_s + O_k \quad (38)$$

$$O_T = Rp130.050.000 + Rp848.332 + Rp1.254.825+ Rp16.717 \quad (39)$$

$$O_T = Rp132.169.874 \quad (40)$$

The actual purchasing cost at CV XYZ Furniture is Rp410,050,000, whereas the proposed purchasing cost based on the calculations is Rp402,852,700. It can be observed that the purchase cost using the continuous review system method yields lower results compared to the actual condition, resulting in savings of Rp7,197,300 or approximately 1.8%. This is due to the proposed quantity of raw material purchases for furniture products based on the raw material requirements in 2022.

Ordering cost is the sum of expenses incurred by the company in carrying out a single ordering activity from the supplier until the goods reach the warehouse. Ordering raw materials from suppliers is done to obtain the necessary raw materials for the smooth running of production processes. The frequency of ordering is a parameter that affects ordering costs. The more frequent the ordering activity, the higher the ordering cost.

The actual ordering cost at CV XYZ Furniture is Rp11,468,748, whereas the proposed ordering cost based on the calculations is Rp6,503,902. It can be seen that the ordering cost using the continuous review system model yields lower results compared to the actual condition. By implementing this model, ordering costs can be reduced by Rp4,964,846 or approximately 43.3% compared to the actual ordering cost. The high actual holding cost is due to the ordering interval not being in line with the warehouse requirements. However, with the continuous review system model proposed, orders are placed when the inventory in the warehouse reaches the reorder point, so the ordering interval is not constant but tailored to the needs of raw materials. The decrease in ordering cost is also due to the optimal order quantity obtained from calculations using the continuous review system method being larger than the actual condition, resulting in fewer orderings and lower ordering costs.

Holding cost is the expense incurred by the company as an investment to support facilities and operations in storing inventory items within the company and the costs arising from storing items in the warehouse. Holding cost is one of the components in the calculation of total inventory costs. Several parameters are used in calculating holding costs, namely the quantity of raw materials available in the warehouse at the end of a certain time interval and the holding cost of raw materials per unit.

The actual holding cost at CV XYZ Furniture is Rp7,635,854, whereas the proposed holding cost based on the calculations is Rp4,151,677, It can be observed that the holding cost using the continuous review system model is higher compared to the actual condition. The increase in holding costs is Rp3,484,176 or approximately 83.4% higher than the actual holding cost. This increase is due to the larger quantity of orders, resulting in more products being stored to avoid stockouts.

Shortage cost is the cost incurred by the company due to demand for a product when the required item is not available in the warehouse. In such cases, the company needs to reorder raw materials from the supplier to produce the product.

The actual stockout cost at CV XYZ Furniture is Rp52,376, whereas the calculated stockout cost is Rp0. It can be seen that the shortage cost using the continuous review system model is higher than the actual condition. This is because there was never a shortage of raw material inventory for furniture products in the actual condition in 2022, while in the proposed continuous review system model, there is an expectation of inventory shortage, resulting in a cost of Rp52,376. This cost is relatively low because based on historical data from 2022, there were no instances of inventory shortage or stockouts, so in the proposed condition, the likelihood of stockouts is low or close to 0, resulting in a low expected shortage cost.

Total inventory cost is influenced by purchase cost, ordering cost, holding cost, and shortage cost. Based on calculated, it can be observed that the proposed total inventory cost decreases compared to the actual total inventory cost. The decrease in total inventory cost using the continuous review system model is Rp8,625,594 or approximately 2.03% of the total inventory cost in the actual condition. The decrease in total inventory cost is due to the decrease in two components of inventory costs: purchase cost and ordering cost.

Based on the comparison of total inventory costs between the actual inventory condition in 2022 and the proposed inventory condition in 2022 using the continuous review system model, it can be proven that the continuous review system model is suitable for calculating raw material inventory at CV XYZ Furniture for raw material planning in the following years.

The continuous review system has been widely recognized for its effectiveness in managing inventories with probabilistic demand. Studies by Kurniawan et al. (2022) emphasize its capability to minimize stockouts, aligning with the findings at CV XYZ Furniture. The reduction in total inventory costs by approximately 2.03% corroborates the efficiency gains reported in similar studies (Munyaka & Yadavalli, 2022; Pardede & Vanany, 2021).

CONCLUSION

Based on the research findings, the conclusions drawn are the raw materials for furniture products at CV XYZ Furniture are classified into three categories: Class A consists of six raw materials, Class B consists of four raw materials, and Class C consists of four raw materials. Proposed inventory planning using the continuous review (s,S) system model is conducted for Class A raw materials of furniture products, while the continuous review (s,Q) system model is applied for Class B and C raw materials of furniture products. This results in the company being able to reduce inventory costs by Rp8,625,594 or 2.026%. The total cost incurred for inventory planning of furniture raw materials for the year 2023 is Rp590,851,887. Product demand is a significant parameter affecting total inventory costs. A 15% increase in demand can increase total inventory costs by 14.75%, while a 15% decrease in demand can reduce total inventory costs by 14.81%. Future research can focus on developing an application for inventory control to enhance the efficiency and accuracy of inventory management at CV XYZ Furniture. This application should incorporate several key features and functionalities to address the complexities of inventory management and provide real-time insights for decision-making.

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NOMENCLATUR

The meaning of symbols used in equations and other symbols presented in your article should be provided in this section.

D	definition from total annual demand
S	definition from standard deviation of demand
L	definition from lead time
α	definition from probability of stockout
Z_α	definition from normal deviation
$f(Z_\alpha)$	definition from ordinate
$\psi(Z_\alpha)$	definition from partial expectation
N	definition from number of stockouts per cycle
SS	definition from safety stock
R	definition from reorder point
q_{0n}^*	definition from optimal order lot size
T	definition from time period
O_b	definition from purchasing cost (Rp)
O_s	definition from holding cost (Rp)
O_p	definition from ordering cost (Rp)
O_k	definition from shortage cost(Rp)
O_T	definition from total inventory cost (Rp)

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