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Spare Parts Inventory Management at PT XYZ Palm Oil Mill

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A B S T R A C T

Spare parts inventory management is an important aspect of supporting smooth production operations in the palm oil industry. A uniform ordering policy may mismatch inventory levels with the demand characteristics of individual spare parts. This study aims to propose a spare parts inventory management policy that is appropriate to the investment value and usage characteristics of each spare parts group at the PT XYZ Palm Oil Mill. The research data consist of 606 spare-part items. A total of 165 items with low usage frequency, namely one to two units per year, were separated and managed using the Base-stock Policy. The remaining 441 items were classified using the ABC method, resulting in 139 Class A items, 133 Class B items, and 169 Class C items. The Continuous Review System with the (Q,r) model was proposed for Class A, the Periodic Review System with the (R,s,S) model for Class B, and the Base-stock Policy for Class C and low-usage items. The calculation results show that the total inventory cost under the proposed policies was IDR 5,554,470,447.17, compared with IDR 5,769,207,095.63 under the existing policy. Thus, the proposed policies resulted in savings of IDR 214,574,146.90 (3.72%). The results indicate that implementing differentiated inventory policies based on ABC classification and usage characteristics can serve as an alternative approach to spare parts inventory management in the company.

Contribution to Sustainable Development Goals (SDGs):
SDG 8: Decent Work and Economic Growth
SDG 9: Industry, Innovation and Infrastructure
SDG 12: Responsible Consumption and Production

1. INTRODUCTION

1.1. Research Background

The palm oil industry is an industrial sector that requires production facilities and equipment to operate continuously. Palm oil mills use various machines and supporting equipment that must operate reliably to meet production targets. The reliability of these machines is closely related to maintenance activities, including the availability of spare parts required for repair and replacement. Spare parts inventory refers to the availability of components or spare parts stored in a company's warehouse to replace parts of machines, heavy equipment, or production facilities that experience failures or require maintenance [1].

The availability of appropriate spare parts enables maintenance and repair activities when equipment fails. Conversely, the unavailability of required spare parts may delay maintenance activities and potentially disrupt production continuity. Selecting an appropriate inventory management technique is important for companies because it ensures spare parts are available as needed, reduces the risk of stockouts and excess inventory, and supports efficient and effective spare parts management. Therefore, inventory constitutes a current asset for both trading and manufacturing companies [2].

PT XYZ operates in the palm oil industry. With a managed plantation area of approximately 16,150 hectares, the company operates several Palm Oil Mills (POMs) distributed across five regencies/cities in Aceh Province. As a crude palm oil (CPO) producer, the continuity of its production processes relies heavily on the reliability of its processing machinery.

Production success largely depends on the inventory system's ability to provide required components on time and in the right quantities. An imbalance between demand and spare parts availability can disrupt both maintenance activities and machine operations. Therefore, an inventory control system is needed that can adjust inventory levels to the dynamics of actual demand in the field.

Table 1. Sample Data of Spare Parts Inventory Transactions at the Palm Oil Mill, 2023–2024

Number	Spare spart	2023			2024		
		Beginning	Incoming	Outgoing	Beginning	Incoming	Outgoing
1	Rubber Coupling 7	0	0	0	0	0	0
2	Bearing NTN 6202	0	0	0	0	0	0
3	Tie rot CB P15	0	1	1	0	0	0
4	Vanbelt C 100	0	6	6	0	0	0

Based on the historical data in Table 1.1, the company's spare parts inventory management system still shows inaccurate procurement timing, as spare parts are procured only after equipment failure creates the need. This condition can be observed in the Tie Rod CB P15 and Vanbelt C 100 items, which experienced stockouts, indicating that safety stock has not yet been established for certain spare parts.

Furthermore, the fact that incoming quantities equal usage indicates that the inventory replenishment system has not been able to anticipate spare parts requirements optimally. Interviews with the Technical Manager of PT XYZ also revealed that failures in the Digester and Press machines had previously caused downtime due to the unavailability of spare parts. Although procurement is scheduled every three months, this policy has not been able to accommodate the requirements of spare parts with high usage rates.

Research on spare parts inventory management has widely employed ABC classification, the Continuous Review System, the Periodic Review System, and other inventory policies. However, applying a single inventory policy to all spare parts groups may not be appropriate because investment value, usage levels, and demand uncertainty differ across items. Spare parts with high investment values require stricter inventory control, whereas spare parts with low investment values and irregular usage frequencies can be managed using simpler inventory policies. Therefore, a proposed inventory policy is needed that links ABC classification results with the usage characteristics of spare parts.

The research gap lies in the limited application of differentiated inventory policies that simultaneously consider investment value and usage characteristics in the research context. This study proposes the use of the Continuous Review System with the (Q,r) model for Class A spare parts, the Periodic Review System with the (R,s,S) model for Class B spare parts, and the Base-stock Policy for Class C spare parts and spare parts with low usage frequencies. This approach aims to obtain inventory policies appropriate to each spare parts group's characteristics and to minimise total inventory costs.

Based on these problems, the research question is: How can an appropriate inventory management policy be proposed for each spare parts group at the PT XYZ Palm Oil Mill to minimize total inventory costs while maintaining spare parts availability? This study aims to propose an inventory management policy based on ABC classification and spare parts usage characteristics, and to compare total inventory costs between the existing and proposed policies.

1.2. Literature Review

1.2.1. Inventory Management

Inventory management is a crucial aspect of the supply chain system, aiming to maintain stock availability at an adequate level by determining the optimal order quantity to meet demand throughout a product's sales period. Optimising daily ordering helps companies minimise lost sales from stockouts while avoiding higher costs from excess inventory [3]. The primary objectives of inventory management are to achieve the desired level of customer service, optimise operational efficiency, and minimise inventory investment without compromising service performance. Spare parts inventory should not be excessive, as it can lead to high holding costs and increase the likelihood of inventory remaining unused (dead stock) [4]. Inventory management is also a system for managing and controlling inventory, including inventory classification and ensuring accurate inventory records [5]. An optimal inventory management system aims to ensure goods are available when and where needed, while minimising the risks of overstock, stockouts, and unnecessary operational costs. Implementing such a system also requires integrated coordination between inventory management and related functions, such as production, marketing, and logistics, so procurement and inventory control processes can operate effectively and in alignment [6].

Inventory management encompasses all activities related to planning, controlling, and monitoring inventory quantity and location to meet market demand [7] efficiently. Three Core Steps in Inventory Management

1. Inventory Procurement: Purchasing and receiving raw materials or components.
2. Inventory Storage: Storing raw materials, semi-finished goods, and finished goods.
3. Inventory Utilization for Profit: Controlling and utilizing products to fulfill customer orders.

Spare parts inventory is defined as stock items used in maintenance activities to maintain the operational condition of equipment or products. Spare parts inventory management is crucial because spare parts costs can constitute a significant portion of a product's life-cycle costs, while spare parts unavailability can result in substantial financial losses for product owners [8]. Industrial settings commonly include several types of inventory [9].

1. Raw Material Inventory: Inventory consisting of basic materials obtained from external suppliers to be used as inputs in the company's production process.
2. Work-in-Process Inventory: Inventory consisting of products that are still in the production stage and require further processing before becoming finished products.

3. Finished Goods Inventory: Inventory consisting of products that have completed all stages of the production process but are still stored and have not yet been marketed or sold.

1.2.2. ABC Classification

ABC classification is a simple method for grouping materials by value and quantity, based on the Pareto principle, which states that approximately 80% of effects result from 20% of causes. In inventory management, this principle implies that approximately 80% of annual consumption typically comes from around 20% of stock-keeping units (SKUs) [10]. ABC classification is an inventory grouping method based on each item's importance, determined by its financial investment value and inventory usage level. Items are ranked by cumulative percentage value, from highest to lowest, and grouped into three categories: Class A, Class B, and Class C [11].

1. Class A: Items with the highest consumption value, accounting for approximately 70–80% of total consumption value, although they represent only 10–20% of the total number of items.
2. Class B: Items with a moderate consumption value, accounting for approximately 15–25% of total consumption value and representing around 25–30% of the total number of items.
3. Class C: Items with the lowest consumption value, accounting for approximately 5% of total consumption value but comprising around 50% of the total number of items.

1.2.3. Continuous Review System

The Continuous Review System (Q,r) is an inventory management policy in which inventory levels are continuously monitored, allowing an order to be placed immediately when the inventory reaches the reorder point. This policy has two main types: the (s,S) policy and the (Q,r) policy. Under the (s,S) policy, when the inventory level falls below the lower limit (s), a new order is placed to replenish inventory up to level (S), and the order quantity varies with demand. Meanwhile, under the (Q,r) policy, a fixed quantity (Q) is ordered whenever the inventory reaches the reorder point (r), so that the order quantity remains constant [8].

Inventory Policy Calculation Using the Continuous Review System. The Hadley–Within method is used to determine (q_0^) and (r^) through an iterative approach using the following formulas [14].

1) Calculating q1*

$q_1^* = \sqrt{\frac{2AD}{h}}$

2) Calculating the standard deviation over the lead tim

$S_L = S\sqrt{L}$

Before calculating the probability of data skewness, first conduct a normal distribution test using the Kolmogorov-Smirnov test in SPSS.

3) Calculate the probability of a stockout

$\sigma f(B)_1 = \frac{S\sqrt{L}hq_1^*}{CuD}$

Next, determine the values of α_1 and $z_{\alpha 1}$

$\alpha_1 = \frac{hq_1^*}{CuD}$

4) Calculating the value r_1^*

$r_1^* = D_L + z_\alpha S\sqrt{L}$

5) The calculation of the shortfall per cycle (N) is performed after first determining the values of $f(z_\alpha)$ and $\Psi(z_\alpha)$ through interpolation from the normal distribution table

$N = S\sqrt{L}\,[f(z_\alpha)_1 - z_{\alpha 1}\,\Psi(z_\alpha)_1]$

After calculating everything, recalculate Q and r as described above to see whether r1 and r2 are equal. If they are not equal, we proceed to the next iteration.

6) Calculating the value q_2^*

$q_2^* = \sqrt{\frac{2D(A+G\alpha 1)}{h}}$

7) Calculating the value r_2^*

$r_2^* = D_L + z_\alpha S\sqrt{L}$

8) Calculating order frequency

$f = \frac{D}{q_0}$

9) Calculating the maximum inventory

$S = q_0 + r$

10) Calculating safety stock (ss)

$ss = z_\alpha S\sqrt{L}$

11) Calculating the service level (η)

$\eta = 1 - \frac{N\ x\ f}{D}\ x\ 100\%$ (2.27)

12) Calculating total inventory costs

$TC = TC_p + TC_o + TC_h + TC_s$

$TC = (p_t\ x\ D) + (f\ x\ A) + h\ x\ (\frac{q_3\ x\ ss}{2}) + (C_u\ x\ P(s)\ x\ f)$

Notation:

q_1^*	: optimal order quantity
A	: ordering cost per order
D	: demand quantity
h	: holding cost per unit per year
$S\sqrt{L}$	: standard deviation over the lead time
α	: alpha
z_α	: z-score of the normal distribution at the α level
$f(z_\alpha)_1$	: ordinate
$\Psi(z_\alpha)_1$	: partial expectation
N	: shortfall per cycle

1.2.4. Periodic Review System

The Periodic Review System is an inventory management policy in which inventory levels are monitored periodically at predetermined time intervals rather than continuously. One example is the (R,S) policy, in which an order is placed at the beginning of each review period (R) to replenish inventory up to a predetermined level (S) [8]. Among the various methods for determining inventory policies, the Periodic Review (R,s, S) System is one approach that can effectively control spare parts inventory [12].

The following presents the steps for calculating the inventory policy using the Periodic Review System method [14].

1) Calculating the review period (R)

$R = \sqrt{\frac{2\ x\ A}{D\ x\ h}}$

2) Calculating the average demand over the review period (X_R)

$X_R = R\ x\ D$

3) Calculate the average demand over the review period and the lead time

$X_{R+L} = (R+L)\ x\ D$

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$\sigma_{R+L} = \sigma \text{ x } \sqrt{\frac{R+L}{R}}$ (Standard deviation during R+L)

4) Calculating the annual heating frequency
$f = \frac{1}{R}$
Calculating the probability of a shortage
Normally distributed data
$F(e) = \frac{h}{Cu \text{ x } f}$
Data that is not normally distributed
$P(s) = \frac{h}{Cu \text{ x } f}$
5) Calculating *safety stock* (ss)
$ss = z \text{ x } \sigma_{R+L}$
6) Calculating maximum inventory (S)
$S = X_{R+L} + ss$
7) Calculating the average demand over the lead time
$X_L = D \text{ x } L$ (2.41)
$\sigma_L = \sigma \text{ x } \sqrt{L}$ (standard deviation of L)
8) Calculating Minimum Inventory (s)
$s = X_L + z\, \sigma_L$
9) Calculating total inventory costs
$TC = TCp + TCo + TCh + TCs$
$TC = p_t \text{ x } D + f \text{ x } A + h \text{ x } (S - \frac{DR}{2} + DL) + Cu \text{ x } P(s) \text{ x } f$

Notation:

R	: review period
A	: ordering cost per order
D	: demand quantity
h	: holding cost per unit per year
X_R	: average demand during the review period
X_{R+L}	: average demand during the review period and lead time
σ_{R+L}	: standard deviation during the review period and lead time
f	: ordering frequency
Cu	: cost of delayed orders per stockout period
P(s)	: Probability of stockout (Probability of shortage)
ss	: safety stock
z	: z-score of the normal distribution
S	: maximum inventory
σ	: standard deviation
σ_L	: standard deviation over the lead time
s	: minimum inventory

1.2.5. Base-stock Policy

The Base-stock Policy is an inventory control policy designed to maintain inventory at a predetermined level. This policy has two main parameters: the maximum inventory level, denoted as (S), and the reorder point, denoted as (r). Whenever demand occurs or one unit is withdrawn from inventory, the company immediately orders one replacement unit to restore the inventory level to (S). In other words, whenever a quantity (D) is issued from inventory, an order for the same quantity (D) is placed [13].

The following presents the steps for calculating the inventory policy using the Base-stock Policy method:

1) Calculating the average demand over the lead time (X_L)
$X_L = D \text{ x } L$
2) Calculating the parameter α as safety stock
$\alpha = \sqrt{2\ln(1 + \frac{Cu}{h \text{ x } L})}$
3) Calculating the maximum inventory level S* (base inventory level)
$S^* = X_L + \alpha\sqrt{X_L}$
4) Calculating the reorder point
$r = S^*-1$
r is not always equal to S-1; rather, S decreases by the number of units used.
5) Calculating the probability of a stockout
$P(s) = \frac{h}{Cu \text{ x } f}$
6) Calculating the frequency of orders
$f = \frac{S^*}{D}$
7) Calculating total inventory costs
$TC = TCp + TCO + TCh + TCs$
$TC = D \text{ x } pt + f \text{ x } A + (h \text{ x } (S-(1-P(s)) \text{ x } XLT) + S \text{ x } Cu \text{ x } P(s)$

1.3. Research Objective

This study aims to propose an appropriate spare parts inventory management policy to minimize total inventory costs at PT XYZ.

2. MATERIALS AND METHODS

This study was conducted at PT XYZ, a company operating in the palm oil industry in Aceh Jaya Regency. This study focuses on spare parts inventory used to support maintenance and production activities.

This study began with a preliminary study to understand the existing spare parts inventory management system. Data were collected through observations of inventory records and interviews with the Technical Manager and warehouse personnel. The preliminary study identified problems related to spare parts availability and the existing procurement system.

The data collected in this study include:
1. Spare parts demand/requirement data
2. Unit prices of spare parts and lead time
3. Ordering costs
4. Holding costs
5. Purchase taxes and other inventory-related costs.

In this study, data processing was carried out using several methods, namely:
1. ABC Classification: This method grouped spare parts according to their investment value or financial expenditure.
2. The classified spare parts were then analysed using three methods: Class A items were analysed using the Continuous Review System, Class B items using the Periodic Review System, and Class C items using the Base-stock Policy.

2.1. Research Design

This study employs a quantitative approach with a case study design at the PT XYZ Palm Oil Mill. The study focuses on managing spare parts inventory to support maintenance activities and ensure continuity of the production process. The quantitative approach analyses spare parts demand, investment value, ordering costs, holding costs, lead time, and inventory costs under the existing and proposed policies.

This study does not employ a community empowerment research design or participatory action research design, as the unit of analysis focuses on spare parts items rather than individuals, community groups, or training participants. Therefore, the indicators used in this study include total inventory cost, cost savings, service level, safety stock, reorder point, and the inventory policy parameters obtained from the analysis.

2.2. Research Object and Data

This study focuses on spare parts inventory items at PT XYZ. The research data consist of 606 spare parts items recorded in the company's inventory system. The data used include spare parts usage, unit prices, inventory quantities, ordering frequency, ordering costs, holding costs, procurement lead time, and other supporting data.

Of the 606 items, 165 items have a low usage frequency, namely one to two units per year. These items were excluded from the ABC classification process because their demand is irregular and they are typically used only when equipment fails or specific needs arise. The remaining 441 items were classified using the ABC method based on their annual investment value. The classification resulted in 139 Class A items, 133 Class B items, and 169 Class C items.

Data collection was conducted through direct interviews with warehouse staff. The data collected included historical spare parts inventory data, spare parts requirements, lead time, ordering costs, and holding costs.

3. RESULT AND DISCUSSION

3.1. Actual Spare Parts Inventory Management Conditions

Under the existing conditions, PT XYZ procures spare parts periodically every three months. However, this policy does not consider each item's inventory level and actual requirements, resulting in overstock and stockouts. Stockouts, particularly for critical spare parts, may cause machine downtime and disrupt production. In addition, these conditions increase inventory costs, particularly through emergency orders and shortage costs from production interruptions.

3.2. ABC Classification

This study included 606 spare parts items at PT XYZ for classification. Of these, 165 spare parts items had a low usage frequency (one to two units per year) and were therefore excluded from the ABC classification process. The remaining 441 spare parts items were classified using the ABC method to determine inventory control priorities based on their annual investment value. Table 2 presents the ABC classification results for the 441 spare parts items.

Table 2. ABC Classification Results and Inventory Control Methods

Number	Class ABC	Number of Items
1	Class A	139
2	Class B	133
3	Class C	169

The 165 spare parts items identified previously were grouped into Class C and managed using the same inventory control policy.

3.3. Inventory Policy Determination for Each Spare Parts Item

The team determined spare parts inventory policies based on ABC classification. Before conducting the ABC classification, spare parts with an annual usage or withdrawal frequency of only one to two units were separated. The remaining spare parts were then classified into ABC classes to determine appropriate inventory policies for each spare parts characteristic based on investment value. Spare parts with an annual usage of one to two units were subsequently managed using the same method as Class C items. The inventory policy determination flow for each ABC classification is presented below.

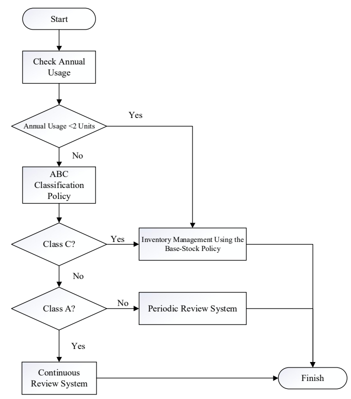

Figure 1. Inventory Policy Determination for Each Spare Parts Item

Based on the inventory policy determination flow presented above, the table below shows the number of items in each classification and the inventory control method applied to each class. We analysed 606 spare parts items, of which 165 low-usage items were managed using the Base-stock Policy, similar to the spare parts in Class C.

Table 3. Methods and Number of Classified Items

	ABC Classification	Number of items	Metode
Annual Usage > 2 units/year	Class A	139	Continuous review system
	Class B	133	Periodic review system
	Class C	169	Base-stock policy
Annual Usage ≤ 2 units/year	-	165	Base-Stock Policy
Total Items	606		

1.3.1 Inventory Policy Using the Continuous Review System Method

The Continuous Review System with the (Q,r) policy continuously monitors inventory levels. An order is placed when the inventory position reaches or falls below the reorder point, with a fixed order quantity equal to the optimal order quantity (Q). This policy is further differentiated based on the demand distribution characteristics of the spare parts, namely normally distributed and non-normally distributed data.

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For spare parts with normally distributed demand data, inventory parameters were determined using the Hadley–Within analytical approach by considering the Z-value. One example is the Bearing 22211 E1K spare part, which has an annual demand of 32 units and a standard deviation of demand during lead time of 0.39 units. Based on the iterative calculations, the optimal order quantity (q) was 5 units, and the reorder point (r) was 2 units. These parameters resulted in a service level of 99.63% with 1 unit of safety stock. In terms of cost, the proposed policy resulted in a total inventory cost of IDR 59,722,443.87, which was lower than the company's actual total inventory cost of IDR 67,392,681.24.

Meanwhile, for spare parts with non-normally distributed demand data, the reorder point was determined using an empirical approach based on the specified service level. For the 12 mm Steel Chain spare part, the optimal order quantity (q) was 11 units, the reorder point (r) was 30 units, and the safety stock was 28 units, with a target service level of 97.5%. Applying the proposed policy resulted in a total inventory cost of IDR 67,392,385.51, lower than the company's actual total inventory cost of IDR 74,086,052.78. The results of the Continuous Review System calculations are presented in Table 4.

Table 4. Sample Results of Continuous Review System Calculations

Spare Part	Unit	q	r	f	ss	Total Cost
Bearing 22211 E 1 K	Pieces	5	2	7	1	IDR 59,722,443.87
Prophane (@ 45 Kg/Btl)	Bottle	7	1	7	1	IDR 45,681,812.78
12 mm Steel Chain	Mtr	11	30	9	28	IDR 67,392,385.51
Screen Assembly Mesh 40 P/N 23	Pieces	1	2	9	2	IDR 82,435,798.07

The results show that safety stock adjusts to each item's demand characteristics. Items with higher demand uncertainty or variability tend to require greater safety stock to reduce the risk of stockouts. In contrast, items with relatively low or stable demand require lower safety stock levels. Overall, implementing the Continuous Review System using the (Q, r) policy reduced total inventory costs by 1.99%.

1.3.2 Inventory Policy Using the Periodic Review System Method

The Periodic Review System with the (R, s, S) policy reviews inventory at predetermined intervals (R). At each review period, an order is placed if the inventory position is below the minimum level (s), with the order quantity sufficient to raise the inventory level to the maximum level (S). The inventory parameters are determined by considering demand during the review period and lead time, as well as safety stock to account for demand uncertainty.

For the group with normally distributed demand data, the inventory parameter calculations are illustrated using the UNP 100 × 6 MTR spare part. This spare part has an annual demand of 11 bars and a standard deviation of demand during the review period and lead time of 0.81. Based on the results, the review period (R) was set to 4 months, the minimum inventory level (s) to 1 bar, and the maximum inventory level (S) to 7 bars, with a safety stock of 2 bars. Applying the proposed policy reduced total inventory cost from IDR 7,512,481.55 under actual conditions to IDR 6,991,467.68 under the proposed policy.

For the group with non-normally distributed demand data, the inventory parameter calculations are illustrated using the Bearing 32309 SKF spare part. Because the demand pattern does not meet the assumptions of a probabilistic distribution, safety stock was determined using the peak annual usage, which was 3 units. The calculation results showed that the review period (R) was set at 4 months, with a minimum inventory level (s) of 3 units and a maximum inventory level (S) of 6 units. Applying the proposed policy reduced total inventory cost from IDR 8,294,784.61 under actual conditions to IDR 8,007,136 under the proposed policy. Table 5 presents the results of the Periodic Review System calculations.

Table 5. Sample Results of Periodic Review System Calculations

Spare Part	Unit	R	s	S	Total Cost
UNP 100 × 6 MTR	Bar	4	1	7	IDR 6,991,467.68
Asbestos Gasket Ø 4 mm	Bottle	6	29	460	IDR 3,135,066.31
Mild Steel Plate 5 mm × 6 m	Mtr	4	10	13	IDR 9,125,525.64
Bearing 32309 SKF	Pieces	4	3	6	IDR 8,007,136

The calculation results show that the optimal review period ranges from 4 to 6 months. Implementing this policy helps maintain inventory at a safe level and reduces the risk of stockouts, particularly for items with high demand variability. Overall, implementing the Periodic Review System resulted in a 10.95% reduction in total inventory costs.

1.3.3 Inventory Policy Using the Base-stock Method

The Base-stock Policy is applied to spare parts with relatively low investment values and irregular demand patterns. This policy maintains the inventory position at a predetermined target level, known as the base-stock level. Whenever spare parts are used, the company places an order equal to the difference between the base-stock level and the current inventory position to restore the inventory to the target level.

We applied the Base-stock Policy to Class C spare parts and the 165 spare parts items with annual usage of one to two units. We calculated the Base-stock Policy for the Adapter Sleeve H511 item, with an annual demand of 24 pcs/year and a lead time of 0.0192 years. The calculation resulted in a target maximum inventory level (S*) of 4 units and a reorder point (r) of 3 units. Implementing this method reduced inventory cost from IDR 3,291,182.80 to IDR 3,103,866.00.

The results of the Base-stock Policy calculations are presented in Table 6.:

Table 6. Sample Results of Base-stock Policy Calculations

Spare Part	S*	r	f	Total Cost
Adapter Sleeve H511	4	3	7	IDR 3,103,866
Welding Wire Nikko Steel Ø 3.2 mm	6	5	9	IDR 3,242,434
Elbow 0.65 mm	4	3	7	IDR 3,076,485
Nut Bolt Ø ¾" × 5"	10	9	12	IDR 3,251,463

The ordering time is not determined periodically but depends on spare parts usage. This mechanism is relatively simple because it focuses on maintaining the inventory level based on demand during the lead time and safety stock. Thus, the Base-stock Policy can maintain spare parts availability, minimise stockout risk, and avoid excessive inventory storage. Implementing this policy reduced total inventory costs by 4.62%.

3.4. Comparison of Existing and Proposed Policies

A comparison of the inventory policies evaluated
the proposed policies' performance against the company's actual conditions. Based on the results, the proposed policies reduced total inventory cost across all items compared with actual conditions. Cost reductions also varied depending on the policy

applied to each ABC classification group. This differs from the policy implemented under the actual conditions, in which all items were managed using the same policy. Under the actual conditions, total inventory cost was IDR 5,689,827,095.63, whereas under the proposed policies, it decreased to IDR 5,554,470,447.17. These results indicate that the proposed inventory policies provide lower total inventory costs than the actual conditions.

Table 7. Sample Data of Spare Parts Inventory Transactions at the Palm Oil Mill, 2023–2024

No.	Class ABC	Existing	Proposed
1	Class A	Rp3.858.459.247,31	Rp3.781.585.078,41
2	Class B	Rp783.986.268,68	Rp698.319.976,22
3	Class C	Rp1.126.761.579,65	Rp1.074.727.894,10

3.5. Novelty

The novelty of this study lies in the proposed inventory control policies, which are tailored to the characteristics of each spare parts group. Unlike previous studies that generally apply the Continuous Review System to Class A items and the Periodic Review System to Class B and C items, this study proposes different inventory control methods based on each group's characteristics. In addition, ordering costs are calculated by separating fixed ordering costs and variable ordering costs, with the latter influenced by the quantity of items ordered. This approach is expected to provide a more representative calculation of total inventory costs and serve as an alternative inventory policy for PT XYZ to minimize costs and improve the effectiveness of inventory control.

4. CONCLUSION

Based on the research findings, the proposed spare parts inventory policies are implemented according to the ABC classification, namely the Continuous Review System for Class A items, the Periodic Review System for Class B items, and the Base-stock Policy for Class C items. Each policy is tailored to the investment level and characterieach group'scs of each group to maintain spare pary and improve cost efficiency. Based on the calculations, the total inventory cost under the existing policy was IDR 5,769,207,095.63, while the total inventory cost under the proposed policies was IDR 5,554,470,447.17. Thus, the proposed policies resulted in a cost saving of 3.72%, with total savings of IDR 214,574,146.90.

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