



INVENTORY CONTROL ANALYSIS WITH ABC CLASSIFICATION, SAFETY STOCK AND REORDER POINT IN SPARE PARTS DISTRIBUTOR COMPANY

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ABSTRACT

Inventory control problems are crucial issues often faced by heavy equipment distributors that provide various types of spare parts and supporting components. Inaccuracy in managing the availability of goods can hamper after-sales service, which ultimately reduces customer satisfaction levels. Conversely, excess inventory has the potential to cause wasteful storage costs, stockpiling, and increased risk of damage or obsolescence of goods. This study aims to evaluate the inventory control system implemented by the company through the ABC classification approach, considering the determination of safety stock and the application of reorder points as part of the inventory optimization strategy. The results of the analysis show that the application of the ABC classification method can increase the accuracy of demand estimates by up to 84%, which has a positive impact on increasing the company's profitability. However, safety stock management still shows weaknesses, especially in the fast-moving goods category, where the inventory level approaches zero. This condition has the potential to cause delays in delivery to consumers. Therefore, a review and improvement of inventory control policies are needed to ensure the continuity of service and the overall operational efficiency of the company.

Keywords: Inventory; spare parts; fast moving; safety stock.

Article History:

Submitted March 03, 2025

Revised March 19, 2025

Accepted March 21, 2025

Available online May 12, 2025

Published By:

Fakultas Teknologi Industri
Universitas Muslim Indonesia

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Jl. Urip Sumoharjo Km. 5 (Kampus II UMI)
Makassar Sulawesi Selatan.

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DOI: <http://dx.doi.org/10.33536/jiem.v10i1.1738>



1. INTRODUCTION

Raw material inventory is a valuable company asset that plays an important role in supporting production activities, so optimal control is needed. The company must be able to control raw material inventory so that it is not too large and not too small (Lahu et al. 2017). The company makes a larger inventory investment to meet the demand for various spare parts (Sheikh, 2023). If the inventory is too large (over stock), then the cost burdens for storing and maintaining inventory in the warehouse will be high so that this will cause waste. Conversely, if the inventory is too small or can be said to be lacking inventory (out of stock), then the delivery time of goods that has been agreed upon between other companies in making purchases of goods (Hawari et al. 2018).

Inventory is an important asset for a company that includes raw materials and semi-finished products. Companies maintain inventory as a reserve to anticipate possible order delays. With inventory, businesses can ensure the smooth running of the production process and are not hampered by delays in the supply of materials (Pradana & Jakaria, 2020)

Inventory is a critical factor in the smooth operation of a business. Proper inventory management is important, because too much inventory can cause money to be trapped in inefficient inventory, increase inventory costs, and increase the risk of damaged goods. Meanwhile, insufficient inventory can lead to the risk of stockouts, hamper business operations, and negatively impact customer satisfaction. Therefore, effective inventory management is an important strategy for businesses to remain competitive in the face of fierce business competition. Reducing inventory holding costs can be offset by increasing other cost components (e.g. production setup costs) or dissatisfied customers (due to poor delivery performance)(Supply chain management 2002).

Classical methods for determining reorder points (ROP) and safety stock levels ignore the inherent variability in lead times and demand. Methods such as economic order quantity (EOQ) require the assumption that demand and lead times are deterministic and will not change (Allmon et al. 2023). Optimized inventory levels and reorder points will lead to more efficient production (Allmon et al. 2023) This study aims to assess inventory classification based on sales history for one year using ABC and Pareto analysis, and to calculate Safety Stock (SS) and Re-Order Point (ROP). In this context, ABC

analysis serves as a tool to select goods based on priority levels, utilizing the Pareto diagram concept to measure financial impact. SS refers to additional stock prepared by the company to address potential spikes in demand for goods, while ROP refers to the inventory threshold that must be maintained in the warehouse before reordering, aiming to avoid running out of stock.

2. METHODS

2.1. Safety stock

Safety stock is needed for uninterrupted flow of demand by delivering non defective products. However, in real-life scenarios, some inventory deteriorate with time (Jana, De, and Goswami 2025). Safety stock is the uncertainty that can cause a company to run out of stock. This is caused by a spike in demand or a spike in demand for various reasons. If this happens, the company must have inventory called safety stock. The following is the safety stock formula(Chopra 2019).

$$\text{Safety stock} = F_s^{-1}(\text{CSL}) \times \sigma L \quad (1)$$

Where;

$F_s^{-1}(\text{CSL})$ = Calculating Service Level

σL = Standard deviation lead time

2.2. Reorder Point

Re-order point is the inventory level or point at which action should be taken to replenish inventory. The reorder point is the inventory level at which a replenishment order should be placed to avoid stockouts during lead time (Hadley and Within, 1963). By calculating the reorder point correctly, you no longer have to worry about stock buildup due to over-ordering, or dealing with frustrated customers due to stock shortages. Here is the re-order point formula.

$$\text{ROP} = d \times L + \text{Safety stock}$$

Where :

d = average demand per period

L = Lead time

When demand or lead time is uncertain, a safety stock component is added, like (Nahmiah, 2005):

$$\text{ROP} = d \times L + \text{Safety stock}$$

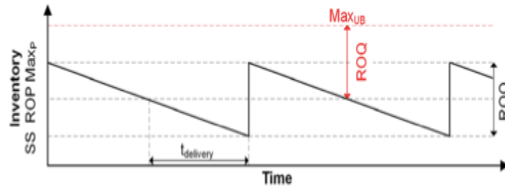


Figure 1. Inventory vs reorder policy
(Eberlein and Freitag 2023)

Figure 1 shows a typical inventory curve under a reorder point policy. The available inventory gradually decreases as the material is consumed. When a certain threshold, called the Re-Order Point (ROP), is reached, an order is placed to replenish the Re-Order Quantity (ROQ), which arrives after a certain delivery time (t_{delivery}), resulting in the maximum planned inventory level (Max P). To implement pull control, both orders and available inventory must be considered. Then, the upper limit (UB) on inventory can be calculated as $ROP + ROQ$. Conceptually, ROP consists of (1) the inventory required to meet consumption during the delivery time and (2) Safety Stock (SS) to cover variations in delivery time and consumption rate. Two main questions arise for a ROP system or statistical inventory model in general: (1) When is the Re-Order Point (ROP), and (2) What quantity to order (ROQ). These questions are answered, namely, based on estimates of delivery time, consumption rate, and cost (Eberlein and Freitag 2023).

2.3. ABC Clasification

ABC analysis is one of the most widely used techniques in inventory management to classify items into three predetermined and ordered categories: A (very important items), B (moderately important items) and C (relatively unimportant items). In the literature, most of the existing classification models treat the ABC inventory classification problem as a ranking problem, i.e. a set of inventory items is ranked in descending order based on their performance expressed by an overall weighted score (Douissa and Jabeur 2016). ABC Clasification is based on Pareto Analysis (Chu, Liang, and Liao 2008)

Tabel 1 M-Rank

<i>Call</i>	<i>M-Rank</i>	Keterangan
12 - 10	A	Fast Moving
9 - 7	B	Medium Moving
6 - 4	C	Slow Moving
3 - 1	D	Very Slow Moving

Where :

Call = Frequency of Demand In Months

M-Rank = Movement Rank

2.4. Z-Score

Z-Score is a statistical value used to measure the distance between an individual data set and the population mean in standard deviation units. Z-score helps to determine the service level where the service level and SS are directly proportional. In this study, the author applies Z-Score using the Excel formula, namely "NORM.S.INV". The following is a graph of the service level and safety stock and a table of values per each M-Rank in figure 2 and Table 2 about Z-Level.

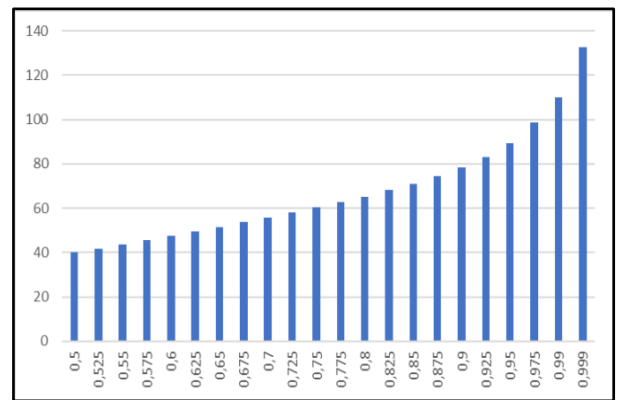


Figure 2. Services Level and Safety Stock

Table 2. Z-Score

<i>M-Rank</i>	Z.SL
A	0.70
B	0.60
C	0.55
D	0.50

Where:

M-Rank = Movement Rank

Z.SL = Z-Score Service Level

3. FINDINGS AND DISCUSSION

3.1. Spare parts data

Information is collected through the company's internal system. This system is used to meet the company's operational needs, including tracking the activity of incoming and outgoing equipment or spare parts. The data collected consists of 30 randomly selected spare parts based on the Goods Receiving Report (GRR) through parts audit trails for the period 2022-2023 can be seen in table 3.

Table 3. Historical Demand for Spare Parts

No	Part Number	Demand (Unit)	No	Part Number	Demand (Unit)
1	1932736	1230	16	51624622	31
2	8715714	359	17	47724311	17
3	LF 7277	218	18	54134001	11
4	LF 6740	527	19	311569AA1	8
5	FS 12312	232	20	51993243	20
6	CC 28969	107	21	845193691	31
7	845685926	53	22	249034780	28
8	515081762	50	23	170910274	35
9	842144564	53	24	51655271	7
10	8753713	112	25	AF 45544 M	6
11	30027525	82	26	GP21930003	14
12	FS197128	66	27	AH 11101	2
13	52594499	13	28	842642721	3
14	19303181	25	29	984060776	3
15	475357939	33	30	56256962	1

3.2. Application of ABC Classification

ABC classification is a grouping method that sorts products based on their value or ranking, starting from the highest value to the lowest value. This method classifies products into four main groups, namely A, B, C and D. This grouping process is based on the variation in the speed of movement of spare parts, from those that move very fast to those that move very slowly. The following is an illustration of the ABC grouping based on Pareto C-D during the period 2022-2023 can be seen in table 4.

Table 4. ABC Classification

No	Part Number	Σ	Ave	Call	Pareto C-D	Pareto (%)	M-Rank
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1	1932736	1230	30	12	1,230	14%	A
2	8715714	359	103	12	1,589	16%	A
3	LF 7277	218	18	12	1,807	18%	A
4	LF 6740	527	10	11	2,334	23%	A
5	FS 12312	232	48	11	2,566	26%	A
6	CC 28969	107	21	11	2,673	27%	A
7	845685926	53	5	11	2,726	28%	A
8	515081762	50	5	11	2,776	28%	A
9	842144564	53	5	10	2,829	28%	A
10	8753713	112	12	9	2,941	69%	B
11	30027525	82	9	9	3,023	90%	B
12	FS197128	66	7	9	3,089	90%	B
13	52594499	13	2	8	3,102	90%	B
14	19303181	25	4	7	3,127	90%	B
15	475357939	33	2	6	3,160	92%	C
16	51624622	31	5	6	3,191	94%	C
17	47724311	17	3	6	3,208	95%	C
18	54134001	11	1	6	3,219	96%	C
19	311569AA1	8	6	6	3,227	96%	C
20	51993243	20	4	5	3,247	96%	C
21	845193691	31	7	4	3,278	97%	C
22	249034780	28	8	4	3,306	97%	C
23	170910274	35	2	3	3,341	97%	D
24	51655271	7	2	3	3,348	97%	D
25	AF 45544 M	6	12	3	3,354	97%	D
26	GP21930003	14	7	2	3,368	100%	D
27	AH 11101	2	1	2	3,370	100%	D
28	842642721	3	3	1	3,373	100%	D
29	984060776	3	1	1	3,376	100%	D
30	56256962	1	3	1	3,377	100%	D

Description :

Σ	: Total Demand
Ave	: Average Demand
Call	: Frequency of Demand In Months
Pareto C-D	: Pareto Call-Demand
Pareto (%)	: Pareto Percentage
M-Rank	: Movement Rank

The definition of Call is A customer frequency or request that triggers an action, such as a reorder or service. Pareto C-D is The item category with the lowest value or frequency of use in the Pareto classification (below categories A and B). And than M-Rank is An internal ranking to assess the priority

of items based on movement, value, or other criteria.

3.3 Safety Stock

Safety stock is the minimum amount of spare parts inventory required by a company, with the aim of preventing potential delays in the supply of spare parts, thereby preventing stock outs. Before determining safety stock, you should first examine the delivery time (lead time). Below are the delivery times for spare parts for the period 2022-2023 in table 5.

After finding the average time or lead time, the next step is to determine the safety stock by calculating the standard deviation of demand and the standard deviation of delivery time, then multiplying it by Z.SL. The following are the results of the safety stock of each spare part for the period 2022-2023 can be seen in figure 3

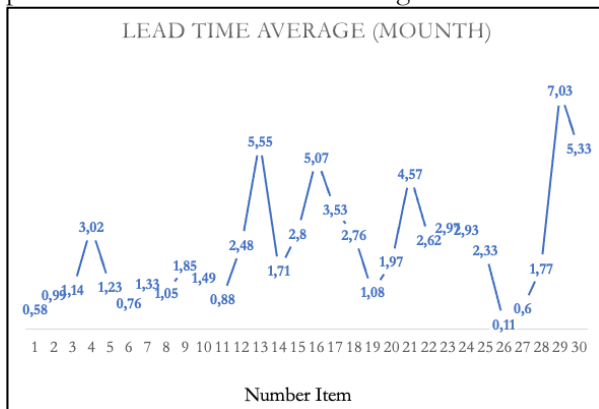


Table 6 Safety Stock

No	Part Number	LTM	Z.SL	STD × Dmd	STD × LT	SS
1	1932736	0.99	0.52	80.14	80	42
2	8715714	1.14	0.52	21.95	22	12
3	LF 7277	0.58	0.52	11.87	12	5
4	LF 6740	0.76	0.52	43.46	43	20
5	FS 12312	1.05	0.52	17.45	17	9
6	CC 28969	1.33	0.52	8.37	8	5
7	845685926	1.23	0.52	3.61	4	2
8	515081762	3.02	0.52	4.12	4	4
9	842144564	1.85	0.52	2.90	3	2
10	8753713	0.88	0.25	12.13	12	3
11	30027525	2.48	0.25	7.94	8	3
12	FS197128	1.39	0.25	6.48	6	2
13	52594499	5.55	0.25	0.99	1	1
14	19303181	1.71	0.25	2.44	2	1
15	475357939	2.76	0.13	1.38	1	0
16	51624622	1.08	0.13	1.21	1	0
17	47724311	3.53	0.13	1.67	2	0
18	54134001	2.80	0.13	1.86	2	0
19	311569AA1	5.07	0.13	0.47	0	0

20	51993243	1.97	0.13	1.26	1	0
21	845193691	2.62	0.13	4.44	4	1
22	249034780	4.57	0.13	5.61	6	2
23	170910274	2.93	0.00	11.61	12	-
24	51655271	2.33	0.00	1.25	1	-
25	AF 45544 M	2.97	0.00	0.00	0	-
26	GP21930003	0.11	0.00	5.00	5	-
27	AH 11101	0.60	0.00	0.00	0	-
28	842642721	5.33	0.00	0.00	0	-
29	984060776	7.03	0.00	0.00	0	-
30	56256962	1.77	0.00	0.00	0	-

Description :

LTM : Lead Time Month
Z.SL : Z-Score Service Level
STD.Dmd : Standard Deviation Demand
STD.LT : Standard Deviation Lead Time
SS : Safety Stock

3.4 Application of Reorder Point

Reorder Point is a certain level (the least amount of spare parts) at which inventory needs to be replenished by the company in order to continue to fulfill orders. By implementing the re-order point concept, companies can reduce the risk of running out of spare parts and also prevent the accumulation or scarcity of spare parts. The following are the calculation results to find the re-order point for the period 2022-2023 can be seen in table 7.

Tabel 7 Re-Order Point

No	Part Number	SS	DL	ROP
1	1932736	42	102	144
2	8715714	12	34	46
3	LF 7277	5	10	15
4	LF 6740	20	36	56
5	FS 12312	9	22	32
6	CC 28969	5	13	18
7	845685926	2	6	8
8	515081762	4	14	17
9	842144564	2	10	12
10	8753713	3	11	14
11	30027525	3	23	26
12	FS197128	2	10	12
13	52594499	1	9	10
14	19303181	1	6	7
15	475357939	0	15	15
16	51624622	0	6	6
17	47724311	0	10	10
18	54134001	0	5	6
19	311569AA1	0	7	7

20	51993243	0	8	8
21	845193691	1	20	21
22	249034780	2	32	33
23	170910274	-	34	34
24	51655271	-	5	5
25	AF 45544 M	-	6	6
26	GP21930003	-	1	1
27	AH 11101	-	1	1
28	842642721	-	16	16
29	984060776	-	21	21
30	56256962	-	2	2

Description :

SS : Safety Stock
DL : Average Demand $\times$ Lead Time
ROP : Re-Order Point

3.5. Discussion

Spare parts are classified based on call or can be said sales in 1 year and Pareto C-D. So spare parts include 4 categories namely A, B, C and D where the classification is sorted from fast moving spare parts to very slow moving. So with the ABC classification, we can determine which spare parts are more prioritized to be sold based on Pareto which can generate demand of 84% by focusing on the pie chart below:

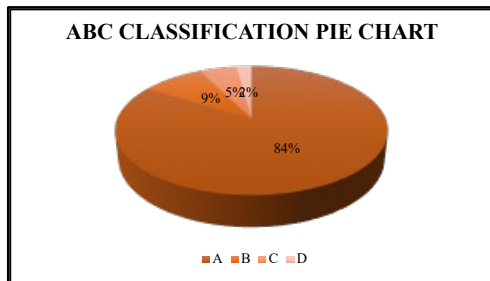


Figure 3. Pie Chart of Spare Parts Classification using ABC

Based on Figure 3 above and table 4 about ABC Classification, Categories A, B, C, and D, identified the total number of items as 2,829, 298, 179, and 71 items respectively. To calculate this total number, it is necessary to combine all items that have been grouped based on their respective classifications. Then, the result is subtracted from the total items found in 30 spare parts. Furthermore, to calculate the percentage of demand, the total items of 30 spare parts are divided by the total number of items in each classification. The use of ABC classification has significant benefits in determining the priority of spare parts that need to be prioritized. This contributes positively to increasing the company's income.

The implementation of Safety Stock/SS in the company, which is the minimum number of spare parts that must always be available, aims to prevent potential delays in the supply of spare parts, as well as to avoid stock-out situations. Therefore, it is very important for the company to implement this reserve stock so that it does not run out of stock, especially for spare parts with a fast-moving classification. Without this action, the company makes back orders which can have negative impacts, ranging from loss of customers to reduced income.

The implementation of Re-Order Point (ROP) is a certain inventory level that indicates when the company needs to reorder spare parts so that orders can still be fulfilled. To calculate ROP on spare parts, the steps needed are to combine Safety Stock/SS with Lead Time/DL. Therefore, the implementation of ROP has significant benefits, namely ensuring that spare part orders can be made at the optimal point and avoiding stock out problems, as well as uncertainty in changes in lead time thanks to the use of standard deviation.

4.CONCLUSION AND SUGGESTION

4.1 Conclusion

Previous identification of spare part sales inventory was less than optimal. However, the Pareto diagram allows for classifying spare parts into classifications, namely ABC, with a sales focus and stock levels at M-Rank A which has a demand of 84% and is very profitable for the company. Spare part lead times vary, but can be overcome by applying standard deviations to lead times so that waiting times are not something to worry about, this makes spare part procurement optimal.

Some supplies that are included in the fast-moving category that are close to zero will affect sales and can result in delays in sending spare parts to customers. Therefore, with SS as a buffer stock, it will help the company avoid stock outs. Implementing ROP to maintain inventory availability in the warehouse at an optimal position

4.2 Suggestion

It is recommended to develop a broader method to be able to identify inventory costs so that there is no cost overrun on inventory.

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