

Multi-Unit Spares Inventory Control – Three Dimensional (MUSIC 3D) Approach to Inventory Control

Zaidatun Ni'mah¹ and Yuniar Farida²

Department of Mathematics, UIN Sunan Ampel Surabaya, zaidatunimahh@gmail.com¹

Department of Mathematics, UIN Sunan Ampel Surabaya, yuniar_farida@uinsby.ac.id²

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Abstrak: Pengendalian persediaan (*Inventory Control*) merupakan serangkaian usaha yang perlu dilakukan bagi setiap perusahaan untuk memaksimalkan keuntungan dari persediaan yang ada. Dalam penelitian ini dilakukan pengendalian persediaan melalui pendekatan MUSIC 3D (*Multi Unit Spares Inventory Control-Three Dimensional Approach*) pada PT. Fajar Mas Murni Surabaya menggunakan tiga analisis yaitu *ABC analysis*, *SDE analysis*, dan *FSN analysis*. Hasil *ABC analysis* menunjukkan bahwa kategori A terdiri dari 6 item (3%) yang memberikan kontribusi 81% terhadap perusahaan, kategori B terdiri dari 16 item (8%) yang memberikan kontribusi 15% terhadap perusahaan, sedangkan kategori C terdiri dari 190 item (89%) yang memberikan kontribusi 4% terhadap perusahaan. Hasil *SDE analysis* menunjukkan bahwa terdapat 127 yang masuk kategori S (60% dari seluruh item), 43 item masuk dalam kategori D (20% dari seluruh item), sedangkan item yang masuk kategori E terdiri dari 42 item (20% dari seluruh item). Hasil *FSN analysis* menunjukkan bahwa terdapat 15 item yang masuk dalam kategori F (7% dari seluruh item), kategori S terdapat 41 item (19% dari seluruh item), dan 156 item masuk dalam kategori N (74% dari seluruh item).

Kata kunci: *inventory control, ABC analysis, SDE analysis, FSN Analysis, MUSIC 3D*

Abstract: Inventory control is a series of efforts that need to be done for each company to generate the maximum profit from existing inventory. In this study inventory control was conducted through the Multi-Unit Spares Inventory Control – Three Dimensional (MUSIC 3D) approach at PT Fajar Mas Murni Surabaya using three analysis, namely ABC analysis, SDE analysis, and FSN analysis. The result of ABC analysis show that category A consists of 6 items (3%) which contribute 81% to company income, category B consists of 16 items (8%) which contributes 15% to company income, while category C consists of 190 items (89%) which contribute 4% to company income. The result of SDE analysis shows that category S consists of 127 items (60% of all items), category D consists of 43 items (20% of all items), while category E consist of 42 items (20% of all items). The result of FSN analysis show that category F consists of 15% (7% of all items), category S consists of 41 items (19% of all items) and category N consists of 156 items (74% of all items).

Keywords: *inventory control, ABC analysis, SDE analysis, FSN Analysis, MUSIC 3D*

1. Introduction

In trading companies, inventory is an important problem that must be managed carefully. Inventory occurs because the amount of goods purchased is greater than the number of goods sold so that it can potentially cause losses. On the other hand, Inventories are economic resources that need to be maintained to support the continuity of sales. Therefore inventory control is needed to minimize costs incurred.

One of the developing trading companies is PT Fajar Mas Murni. PT Fajar Mas Murni is a trading company in the field of equipment in various sectors. So far, inventory control at PT Fajar Mas Murni has not used a specific method that can control inventory in the company. The company has excess inventory on many items and sometimes has a shortage of inventory on certain items. Of course, the cost of inventory caused is not small. So it is necessary to control inventory so that there is no excess or lack of inventory.

Inventory control can be approached by several methods including EOQ (Economic Order Quantity) and ROP (Re-Order Point) method, ABC analysis, SDE (Scarce, Difficult, and Easy) analysis, and FSN (Fast, Slow, and Non-Moving) analysis. In this study, the author used three analyzes to control inventory, namely ABC analysis, SDE analysis, and FSN analysis which were combined in the MUSIC 3D (Multi-Unit Spares Inventory Control – Three Dimensional) approach to obtain the optimal solution from each item group. ABC analysis results are obtained based on total sales volume. SDE analysis results are obtained based on the lead time, and FSN analysis is obtained based on the turn over of each item.

Studies related to inventory control include the analysis of the Economic Order Quantity (EOQ) method as an inventory evaluation at PT Fajar Mas Murni Batam [1], The application of EOQ and ROP method [2], Application of ABC analysis in controlling inventory of furniture products at Java Furniture Wonosari Klaten [3], The application ABC analysis for inventory control of consumable items [4], Classifying spare parts and its vendor selection models at the metering station at PT Chevron Pacific Indonesia [5], Analysis of spare parts classification using MUSIC 3D view of spares [6], The company control analysis using the MUSIC 3D (Multi-Unit Spares Inventory Control – Three Dimensional) approach in the warehouse at PT Semen Indonesia (PERSERO) Tbk Tuban [7].

The three analysis approach using MUSIC 3D is still not widely used, but the MUSIC 3D approach can produce a more accurate inventory control analysis because combining the three analysis is better than just using one analysis.

2. Theoretical Basis

2.1 Inventory

Inventory is an economic resource that needs to be held and maintained to support smooth production. These economic resources can be in the form of production capacity, labor, experts, working capital, time available, raw materials, finished goods, items are in the process of being worked on, and auxiliary materials [8] [9] [10].

Inventory occurs if the amount of goods purchased is greater than the amount used. According to [3] [11], the purpose of the inventory is:

- Storing resources to provide good service to customers
- Buffer inventory to anticipate inventory shortages and inventory stockout
- Transit inventory
- To anticipate price fluctuations every year
- Quantity discount
- Seasonal inventory

Based on the benefit above, the availability of inventory is important for each company, but if the quantity of inventory is excessive, it will cause losses due to inventory cost, so it is necessary to have inventory control.

2.2 Inventory Control

Inventory Control is a series of activities that need to be carried out by each company so that there is no accumulation of goods in the warehouse [8] [12]. The factors that influence inventory control are as follows:

- Total sales

Total sales are the total amount generated from the sale of each item within a certain period to obtain maximum profit to be able to support the development of the company. The greater the total value of the sales, the greater the profits earned by the company too. The total sales value is obtained based on the following equations (1) and (2).

$$T = n \times HPP(j) \tag{1}$$

$$T = n \times [HPP(b) + margin] \tag{2}$$

where :

- T = total sales
- n = number of items sold
- $HPP(j)$ = cost of items sold
- $HPP(b)$ = cost of purchase

- Lead Time

Lead time is waiting time what the company needs, starting from ordering items until the item arrives. Lead time is one of the important factors in inventory control because if the company does not take into account lead time on procurement of inventory in the warehouse, it will hamper the process of sending the item to the customer. This causes the waiting time of each item to be estimated even though there is still a risk of errors in the assessment.

- Inventory Turnover

Inventory turnover is the ratio to measure the efficiency of inventory management of items that can control the capital in inventory. The higher the ratio, getting better and increasingly showing efficient inventory management. Turnover values can be obtained based on equation (4) [13].

$$ITO = \frac{n}{\bar{X}p} \tag{3}$$

$$\bar{X}p = \frac{P(o)+P(a)}{2} \tag{4}$$

where :

- ITO = Inventory turnover
- n = number of items sold
- $\bar{X}p$ = average lot size
- $P(o)$ = initial inventory
- $P(a)$ = ending inventory

Based on these factors above, an approach is needed to manage inventory using MUSIC 3D (Multi-Unit Spares Inventory Control – Three Dimensional).

2.3 MUSIC 3D

MUSIC 3D is a method to classify item products of the company using three-dimensional approach. According to [14] there are several types of item classifications that need to be considered in the MUSIC 3D approach shown in Table 1.

Table 1. Category of Classification

No.	Category	Criteria
1	ABC analysis	Sales volume
2	SDE (<i>scarce, difficult, easy</i>) analysis	lead time
3	FSN (<i>fast, slow, non-moving</i>) analysis	turn over
4	HML (<i>high, medium, low</i>) analysis	The price of each item
5	VED (<i>vital, essential, desirable</i>) analysis	Critical level of each item
6	GOLF (<i>govt, ordinary, local, foreign</i>) analysis	Technical payment based on supplier location
7	SOS (<i>seasonal, off-seasonal</i>) analysis	Seasonal items

In this study, MUSIC 3D using three dimensions as a combination of three types of classification, namely ABC analysis, SDE analysis, and FSN analysis. Here's the explanation:

2.3.1 ABC Analysis

ABC analysis is a method which classifies inventory into three groups based on the volume of sales in a particular period. ABC analysis uses the concept of Pareto law that says 80/20 means that 80% of a company's sales (company income) is generated by 20% of items [15]. The steps of the ABC analysis method are [16]:

- Collecting sales data (last 12 months) for each item.
- Sales sort items from the largest to the smallest.
- Calculating the percentage of sales of each item to total sales, then make a cumulative percentage.
- Cumulative percentage calculation is obtained based on equation (5).

$$\%Kum. (m) = \%penj. + (m - 1) \tag{5}$$

$$\%penj. = \frac{T(m)}{T(n)} \times 100\% \tag{6}$$

where :

- $\%Kum.$ = cumulative percentage
- $\%penj.$ = percentage of total sales
- n = number of items sold
- m = 1,2,3,...,n
- $T(m)$ = total sales
- $T(n)$ = total sales of all items

Grouping of ABC analysis is shown in Table 2.

Table 2. Criteria of ABC Analysis

No.	Group	$\%Kum.$
1	A	up to 80%
2	B	81% – 96%
3	C	>96%

2.3.2 SDE Analysis

SDE (Scarce, Difficult, and Easy) analysis is based on the lead time of each item. Lead time is the time needed to order items from suppliers until the items arrive at the company [7]. The criteria for each group are shown in Table 3.

Table 3. Criteria of SDE Analysis

No.	Group	Criteria
1	S (<i>scarce</i>)	>60 days
2	D (<i>difficult</i>)	31 – 60 days
3	E (<i>easy</i>)	1 – 30 days

2.3.3 FSN Analysis

FSN (Fast, Slow, and Non-Moving) analysis is a classification of items based on the turnover value of each item. Inventory turnover shows how many times the item came out or replaced in a certain period. Turnover value is obtained based on equation (3) [7]. The criteria for each group are shown in Table 4.

Table 4. Criteria of FSN Analysis

No.	Group	Turnover
1.	F (<i>fast moving</i>)	>4 times rotating in one year
2.	S (<i>slow moving</i>)	$1 \leq x \leq 4$ times rotating in one year
3.	N (<i>non-moving</i>)	Does not rotating in one year

3. Research Methods

3.1 Data

This study uses data obtained from PT Fajar Mas Murni Surabaya in 2017 precisely in the warehouse section. The data consists of 212 compressor spare part items that have sales price (**Price**), the number of incoming items (**In**), the number of items coming out or total sales (**Out**), the number of initial inventory (**P(o)**), the number of ending inventory (**P(a)**) and lead time of an item (**Lt**). The data used are shown in Table 5.

Table 5. Data used

No.	Part Number	Descriptions of the Items	Price	In	Out	$P(o)$	$P(a)$	Lt (days)
1.	38459582	SSR ultra coolant (39433735)	xxx	1013	846	5	172	89
2.	39433743 PLT	Coolant-ultra,208 litre	xxx	4	3	0	1	89
3.	54509435	Element separator (89213011)	xxx	23	23	3	3	99
4.	22219174	El.separator (54509500/39863873)	xxx	25	22	2	5	99
5.	39433743	Coolant - ultra, 208 litre	xxx	9	7	0	2	89
...
212.	39844113	Filter, hi-dust 14 inch	xxx	0	0	1	1	94

3.2 Data Processing Steps

- a. ABC analysis :
 - Sorting sales of each item from the largest to the smallest.
 - Making a cumulative percentage based on equation (5) and (6)
 - Classifying total sales of an item based on criteria on table 2
- b. SDE analysis :
 - Classifying lead time of item based on criteria on table 3

- c. FSN analysis :
 - Calculating turn over of each item based on equation (3) and (4).
 - Classifying turn over of item based on criteria on table 4.
- d. Combining three analysis above into one using MUSIC 3D approach, then analyzes how to overcome or contribute to what policy analysis can be used as consideration for PT Fajar Mas Murni Surabaya.

4. Result and Discussion

212 data of spare parts items was obtained from the warehouse of PT Fajar Mas Murni Surabaya and processed into three classifications, namely ABC analysis, SDE analysis, and FSN analysis. The results of each classification are then combined into one in the MUSIC 3D method. Here is a description of each analysis:

4.1 ABC Analysis Result

ABC analysis is a method which classifies inventory into three groups based on the volume of sales in a particular period. From the results of the cumulative frequency calculation in equations (5) and (6), it produces three groups, namely, A, B and C. These results indicate that from 212 spare parts items totally, 6 items are in category A with a percentage of total items of 3% which contributes to sales of 81% of all items, 16 items included in category B with a percentage of total items of 8% which contributes to sales of 15% of all items, and 190 items included in category C with a percentage of total items 89% contributing sales of 4% of all items. The result of spare parts classification using the ABC analysis shown in Figure 1.

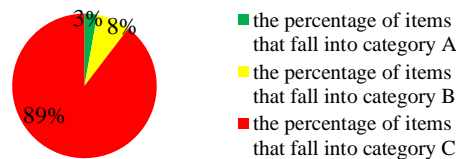


Figure 1. ABC analysis pie chart

Based on these results, the items SSR Ultra Coolant with part number 38459582 have a very high total sales that each year these items provide 53.68% of the company's total sales, so it needs strict supervision and care to avoid losses. While 190 items included in category C means that for the next period inventory in the warehouse can be reduced and does not require intensive supervision.

4.2 SDE Analysis Result

SDE analysis is based on the lead time of each item. The classification of SDE analysis is obtained from the criteria shown in table 3. This result indicated that from 212 spare parts items totally, there are 127 items that included into the category S (scarce) or 60% of all items, 43 items in the category D (difficult) or 20% of all items, and 42 items included in the E (easy) category or 20% of all items. The result of spare parts classification using SDE analysis shown in Figure 2.

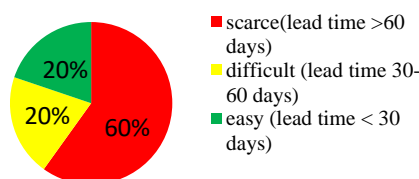


Figure 2. SDE analysis pie chart

Based on the results of SDE analysis, item Hose Assembly has the highest lead time 256 days and do not have a total value of sales, this means that item not sold at all in one year. This results in a Hose Assembly item that does not require strict supervision. While the Element Separator item by part number 54509435 in the category of S (scarce) because it has a lead time of more than 60 days with 79 days. Although the lead time is long enough, the item is an item that has a high total sales value for the company, so that the item needs to be closely monitored in terms of the quantity ordered.

4.3 FSN Analysis Result

FSN analysis is a classification of items based on the turnover value of each item. The classification of FSN analysis is obtained from the criteria shown in table 4. This result indicated that from 212 spare part items totally, there are 15 items that included in category F (fast moving) or 7% of all items, 41 items are categorized as S (slow moving) or 19% of all items and 156 items included in the category N (non-moving) or 74% of all items. The result of spare parts classification using FSN analysis shown in Figure 3.

The results of the FSN Analysis show that there are more than 50% of non-moving items. Thus, in the next period, the company can reduce the lotsize of items included in the category of non-moving (N) to minimize storage costs. The items that have the highest turnover are the Element Air Filter item which in one year the item rotates 22 times. Although it has the highest turnover, the item does not have a high total sales, so in the ABC analysis above, it is categorized as C. While items that need strict supervision are Ultra Coolant SSR items because, in addition to having a high turnover, the total sales owned are very high, which greatly supports the company's income.

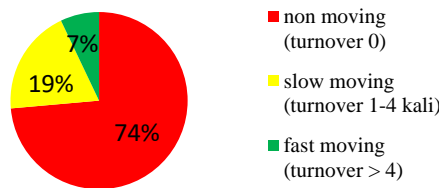


Figure 3. FSN analysis pie chart

4.4 MUSIC 3D Result

MUSIC 3D is an approach method that combines three analyzes, they are ABC, SDE, and FSN. The result of MUSIC 3D approach for each item is shown in table 6.

Table 6. Category of each items using MUSIC 3D approach

No.	Part Number	Descriptions of the Items	Category
1.	38459582	SSR ultra coolant (39433735)	ADF
2.	39433743 PLT	Coolant-ultra, 208 litre	ADF
3.	54509435	Element separator (89213011)	ASF
4.	22219174	El.separator (54509500/39863873)	AEF
5.	39433743	Coolant - ultra, 208 litre	ADF
...
212.	39844113	Filter, hi-dust 14 inch	CSN

By using MUSIC 3D approach, policy analysis can be obtained that can be used as consideration for PT Fajar Mas Murni Surabaya. The policy analysis submitted to the company is shown in Table 7.

Table 7. The Policy analysis to inventory control

No.	Category	Quantity Item	The Policy Analysis to inventory control
1	ASF	1	Items that included in this category are items that should get strict supervision and maintenance for the warehouse.
2	ADF	3	Items that included in this category are items that should get fairly strict supervision and maintenance for the warehouse.
3	AEF	2	Items that included in this category are items that should get scheduled maintenance for the warehouse.
4	BSF	1	Items that included in this category are items that should get routine supervision and maintenance but futures.
5	BSS	2	Items that included in this category are items that need to be scheduled for calculation using the EOQ method without the need for direct supervision.
6	BSN	2	The company only makes an order if the item in a state of low inventory.
7	BDS	2	Items that are included in this category are an item that needs to be scheduling calculations using EOQ method without the need for direct supervision.
8	BEF	4	Items that are included in this category an item that must be scheduled and performed calculations direct supervision.
9	BES	4	Items that are included in this category an item that needs to be scheduling calculations using EOQ method without the need for direct supervision.
10	BEN	1	The company only orders if needed and if the item is in a low inventory condition.
11	CSF	2	The company needs to plan an inventory schedule.
12	CSS	7	The company only needs to make an allowance in supervision and make an order if the item is in a low inventory condition.
13	CSN	112	The company only orders if the item is in a low inventory condition
14	CDF	1	The company needs to plan an inventory schedule.
15	CDS	9	The company only needs to make an allowance in supervision and make an order if the item is in a low inventory condition.
16	CDN	28	The company only orders if the item is very low inventory.
17	CEF	1	The company needs to plan an inventory schedule.
18	CES	17	The company only needs to make an allowance in supervision and make an order if the item is in a low inventory condition.
19	CEN	13	The company only orders if needed and if the item is in a very low inventory condition

5. Conclusion

Inventory control of spare part items using ABC analysis shows that category C (category of small total sales value) is more dominant, that is 190 items and contributes 4% to company income rather than categories A and B where both categories have a large total sales value. While the calculation with SDE analysis shows that the S category (category whose item has a waiting time > 60 days) is more dominant, there are 127 items or 60% of all items than the D and E categories that have a waiting time of <60 days. Then using FSN analysis, it shows that the N category (a category that is not rotating at all in one year) is more dominant, that is there are 156 items or 74% of all items rather than the F and S categories, namely the fast moving and slow categories moving.

The three's analysis approach (ABC, SDE, and FSN analysis) were combined into MUSIC 3D approach shows that there is one item that needs strict

supervision and maintenance, it is Element Separator with part number 54509435. This is because the separator element has a high selling price and a long order time of 79 days and is classified as a fast-moving item.

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