Toward a green inventory controlling using the ABC classification analysis: A case of motorcycle spares parts shop

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Abstract. SSM is a large training unit, which focuses on selling the spare parts for the vehicle. Their current problems were the unwell-organized warehouse layout and the lack of distance of the shelves causing the warehouseman facing the difficulty in terms of inventorying the goods management. The overstocked supply usually occurs at the end of the year because of oversupply. This study used the ABC classification method for the rearrangement of their facility layout based on the demand. As a result, brake pad, outer tire, and engine oil, which were classified in A group (fast-moving), must be relocated closer to the access gate. By this arrangement, it could minimize the movement of the personnel up to 133,318.55 m annually. Moreover, using the Economic Order Quantity (EOQ) method, the order period, safety stock, and Re-Order Point (ROP) could be optimized, and the total supply would minimize cost.

1. Introduction
One of the optimal criteria of a reliable supply management system is the system that could minimize the total costs to the supply. The total cost depends on the storage cost, order costs, and shortages of inventory cost. On the other hand, the decision variables in the traditional supply control management only consider the quantitative and qualitative variables.

The Economic Order Quantity (EOQ) is one of the supply-demand models that calculate the quantity, order frequency, and order value at the most economical level [1]. In most situations related to the inventory control of finished goods, this method is applicable [2, 3]. Other essential tools in the supply-demand model are The ABC analysis [4]. This method divides the supply into three classifications based on the item annual cost. The basic idea is to create demand policies on the significant stock. Class A items are the fast-moving category with an annual inventory of more than 15% of the total inventory and have a price value between 70-80%. The class B items are the medium-moving category with annual inventory up to 30% and the total amount between 15-25%. The class C items are the slow-moving category with less than 5% annual inventory and 55% of the investment value. This ABC analysis involves the classification of inventory stock based on the priority level, and implementing the operation management for the classification result with each control level. Category Class A item must be located in the ‘Golden Zone’ area where the items can be mobilized easily and fast. Category B is located in ‘Silver Zone’ area where items are located after or close to the Golden Zone. Category C is located in ‘Bronze Zone’ where it is the item can be put at the furthest and can locate at the topmost and/or backmost [5].
SSM as a vehicle spares parts shop is required to satisfy their customer by maintaining their stock of the various types of motorcycle spare parts in the level of their demand. Therefore, the company must have a reliable management system in controlling their supplies. The existing supply controlling system was to determine the quantity and order period based only by the supply record. The purposes of this study were to classify the inventories owned by SSM into groups that were easily managed to obtain optimal supply costs. Base on the classification, the existing shop floor layout then re-arranged to have an ergonomic layout.

2. Methods
This study used secondary data: demand, order data, spare parts costs, order cost, and storage cost for the spare parts between January-December 2018. The data then classified using the ABC method to determine the class of each item in the inventory. The normal distribution data analyzed using the Minitab software.

3. Result and discussion
3.1. The Inventory Control
The demand data, as well as its total price and cumulative price, are presented in table 1. Using Pareto method, those spare parts were classified.

| Spare Parts Type | Demand | Total Price (Rp) | Cumulative Price (Rp) | Cumulative Price (%) | Class |
|------------------|--------|------------------|-----------------------|----------------------|-------|
| Motor Oil        | 5,944  | 4,491,842,400    | 4,491,842,400         | 42.21                | A     |
| Motor Inner Tire | 4,134  | 2,638,173,150    | 7,130,015,550         | 67.00                | A     |
| Motor Outer Tire | 8,673  | 1,441,714,000    | 8,571,729,550         | 80.54                | B     |
| Dry Battery      | 973    | 732,886,700      | 9,304,616,250         | 87.43                | B     |
| Chain Packaged   | 5,731  | 669,287,200      | 9,973,903,450         | 93.72                | B     |
| Car Outer Tire   | 1,237  | 405,603,430      | 10,379,506,880        | 97.53                | C     |
| Brake pad        | 15,322 | 262,840,500      | 10,642,347,380        | 100.00               | C     |

The calculation result for lot sizing of engine oil by using the EOQ method is presented in table 2.

| Spare Part Type | Price (Rp.) | Profit (Rp.) | HC  | SL  | Z    | µ √ L | S_d | SS | DDLT | ROP |
|-----------------|-------------|--------------|-----|-----|------|-------|-----|----|------|-----|
| 4 Stroke Oil Y  | 972,000     | 25,000       | 2,352.32 | 91% | 1.34 | 62 | 0.48 | 4.68 | 3   | 14  | 17  |
| Matic Oil Y     | 876,000     | 25,000       | 2,352.32 | 91% | 1.34 | 54 | 0.48 | 5.51 | 4   | 13  | 17  |
| 2 Stroke Oil Y  | 840,000     | 25,000       | 2,352.32 | 91% | 1.34 | 54 | 0.48 | 4.65 | 3   | 13  | 16  |
| 4 Stroke Oil F  | 684,000     | 26,000       | 2,352.32 | 92% | 1.41 | 54 | 0.48 | 4.39 | 3   | 13  | 16  |
| 4 Stroke Oil AHM| 912,000     | 18,000       | 2,352.32 | 88% | 1.17 | 37 | 0.48 | 3.73 | 2   | 9   | 11  |
| 2 Stroke Oil M  | 616,000     | 20,000       | 2,352.32 | 90% | 1.28 | 53 | 0.48 | 4.14 | 3   | 12  | 15  |
| 2 Stroke Oil AHM| 858,000     | 18,000       | 2,352.32 | 88% | 1.17 | 35 | 0.48 | 5.36 | 3   | 8   | 11  |
| 4 Stroke Oil M  | 538,500     | 20,000       | 2,352.32 | 90% | 1.28 | 53 | 0.48 | 4.94 | 3   | 12  | 15  |
| 2 Stroke Oil C  | 738,600     | 22,000       | 2,352.32 | 90% | 1.28 | 27 | 0.48 | 3.56 | 2   | 6   | 8   |
| Matic Engine Oil F| 538,600 | 26,000       | 2,352.32 | 92% | 1.41 | 26 | 0.48 | 3.83 | 3   | 6   | 9   |
| 4 Stroke Oil C  | 693,850     | 22,000       | 2,352.32 | 91% | 1.28 | 28 | 0.48 | 2.86 | 2   | 7   | 9   |

The determination of the order quantity and total demand cost annually by using the EOQ method presented in table 3.
Table 3. The EOQ calculation of order quantity for motor oil data

| Spare Parts Type | Holding Cost | Demand/Year | SS | EOQ  | Demand/Year |
|------------------|--------------|-------------|----|------|-------------|
| 4 Stroke Oil Y   | 2,352.32     | 740         | 3  | 79   | 9,367 ≈ 9   |
| Matic Oil Y      | 2,352.32     | 646         | 4  | 74   | 8,729 ≈ 9   |
| 2 Stroke Oil Y   | 2,352.32     | 651         | 3  | 74   | 8,688 ≈ 9   |
| 4 Stroke Oil F   | 2,352.32     | 645         | 3  | 74   | 8,716 ≈ 9   |
| 4 Stroke Oil AHM | 2,352.32     | 448         | 2  | 62   | 7,225 ≈ 7   |
| 2 Stroke Oil M   | 2,352.32     | 635         | 3  | 74   | 8,581 ≈ 9   |
| 2 Stroke Oil AHM | 2,352.32     | 423         | 3  | 60   | 7,057 ≈ 7   |
| 4 Stroke Oil M   | 2,352.32     | 640         | 3  | 74   | 8,648 ≈ 9   |
| 2 Stroke Oil C   | 2,352.32     | 326         | 2  | 53   | 6,150 ≈ 6   |
| Matic Oil F      | 2,352.32     | 311         | 3  | 51   | 6,098 ≈ 6   |
| 4 Stroke Oil C   | 2,352.32     | 336         | 2  | 54   | 6,222 ≈ 6   |

3.2. Suggested Facility Layout by Using the ABC Classification

The existing layout of SSM (table 1) used the similarity principle by categorizing similar goods or located closely.

![Figure 1. The existing layout of SSM (Scale 1:100)](image)

By using the ABC classification analysis, it obtained the spare parts classification to determine the layout according to the classification category. The classification of the spare parts presented in table 4.

Table 4. The ABC classification analysis for the spare parts based on the demand

| Spare Parts Type       | Demand | Demand Cumulative | Demand Percentage (%) | Class |
|------------------------|--------|-------------------|-----------------------|-------|
| Brake Pad              | 15,322 | 15,322            | 36.47                 | A     |
| Motorcycle Outer Tire  | 8,673  | 23,995            | 57.11                 | A     |
| Motorcycle Engine Oil  | 5,944  | 29,939            | 71.26                 | A     |
| Chain Set              | 5,731  | 35,670            | 84.90                 | B     |
According to the ABC classification analysis result, it obtained that the spare parts categorized in class A were brake pad, motorcycle outer tire, and engine oil. Therefore, these spare parts were the top priority to be located close to the warehouse access gate and being marked with yellow boxes. By considering the processing data result, the recommendation for the layout design presented in figure 2. This recommended layout could increase the efficiency movement.

![Figure 2. Suggested layout design for SSM (Scale 1:100)](image)

Table 5 shows the accumulation of movement model distance of the warehouseman when SMM use the existing layout compared with the suggested layout.

| Spare Parts Type | Existing (mm) | Suggested (mm) |
|------------------|---------------|----------------|
|                  | Demand | Distance | Cumulative | Demand | Distance | Cumulative |
| Oil Y            | 2,037  | 66.55    | 135,562.35  | 2,037  | 17.87    | 36,401.19  |
| Oil C            | 662    | 164.09   | 108,627.58  | 662    | 220.59   | 146,030.60 |
| Oil AHM          | 871    | 128.56   | 111,975.76  | 871    | 123.70   | 107,742.70 |
| Oil M            | 1,275  | 204.74   | 261,043.50  | 1,275  | 123.70   | 127,640.30 |
| Oil F            | 956    | 252.15   | 241,055.40  | 956    | 144.87   | 138,495.70 |
| Inner Tire 2.75-17 | 1,036  | 16.60    | 17,197.60   | 1,036  | 196.38   | 203,449.70 |
| Inner Tire 2.50-17 | 1,031  | 25.75    | 26,548.25   | 1,031  | 149.32   | 153,948.90 |
| Inner Tire 2.75-14 | 1,038  | 236.56   | 245,549.28  | 1,038  | 110.81   | 115,020.80 |
| Inner Tire 2.50-14 | 1,029  | 266.85   | 274,588.65  | 1,029  | 160.67   | 165,329.40 |
| Outer Tire 2.75-17 | 2,274  | 190.01   | 432,082.74  | 2,274  | 133.49   | 303,556.30 |
| Outer Tire 2.50-17 | 2,223  | 102.45   | 227,746.35  | 2,223  | 101.04   | 244,618.90 |
| Outer Tire 2.75-14 | 2,266  | 172.16   | 390,114.56  | 2,266  | 89.73    | 203,328.20 |
| Outer Tire 2.50-14 | 2,102  | 138.77   | 291,694.54  | 2,102  | 109.84   | 230,883.70 |
| Brake Disk       | 7,948  | 102.45   | 814,272.60  | 7,948  | 45.79    | 363,938.90 |
4. Conclusion

This study shows that the motor oil and motorcycle inner tire were the two spare parts that need a specific arrangement. Using the EOQ method, the supply capacity of each spare parts type has been determined. The EOQ method also could minimize the total demand cost compared to the existing method. Using the popularity principle of the ABC classification method, considering the demand frequency, the Class A (fast-moving) inventories were the brake pad, outer tire, engine oil. The Class B inventories consist of engine chain set and inner tire. The accumulator part was classified as slow-moving items (Class C). Using those classifications result, the layout of the shop floor was re-arrange and could minimize the movement distance of the warehouseman up to 135,319.2 meters within a year.

References

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