Inventory planning analysis for vehicle spare parts by using Continuous Review method: A green engineering approach

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Abstract. PT Y is the largest dealer in the eastern part of Indonesian focuses on selling, supply, and maintenance of vehicle spare parts. This research aims to determine the optimal quantity order and reorder, and safety stock to anticipate the possibility of stockout or extra cost, and to fulfill the customer needs. We implemented the ABC analysis for vehicle spare parts Mirage type, then create scheduling for spare parts in class A that normally distributed. In this plan, future demand determined which later improve the inventory management of the spare parts by determining the order quantity, reorder point, safety stock, and total cost of inventory by using the Continuous Review method, which results in the optimal value. The Continuous Review method obtains the total saving for inventory cost up to 54.21% and able to be the optimal solution applied by the company in the future.

1. Background
It is required for the company to meet demand customer both in quality as quantity aspects at the ordering process of goods. When those factors can be fulfilled, it obtains the satisfaction of the customer that causes more frequent order for the next period. If the customers need the goods at the exact time and quantity, it will encourage the company to anticipate that order by having available stock. The inventory is a critical issue to be supplied by the company at a specified period [1].

Inventory management is a process of planning, supplying, and controlling of supply level of needed goods to obtain the optimal performance [2]. It is necessary for the company to providing the stock to anticipate the unplanning operational condition, uncertain demand and supply, and to get the economies of scale in the production process [3]. There are types of cost in the inventory system that the company should be aware of, which are purchasing cost, procurement cost, ordering cost, setup cost, holding cost, and backorder/shortage cost [4, 5].

The Continuous Review is a method where the inventory level monitored frequently, so when the inventory level reaches Reorder Point (ROP) level, the ordering should execute [6]. The Periodic Review method is a periodically reorder system with constant interval period, such as weekly, monthly, or quarterly, with a varied amount of order according to the previous consumption review [7, 8].

PT Y is a trustable service company that focuses on maintenance, spare parts supply, and selling vehicles. This company serves 15 cars on average daily. Hence, it involves the availability of the spare parts as the primary needs. According to the observation and interview, in terms of maintaining the
inventory to determine the order only based on the spare parts stock from the previous months or specific conditions, when the company orders in the situation of unfulfilled the customer demand both in terms of time and quantity, known as a backorder. In the case of a backorder, the company will fulfill the customer needs by the unfulfilled condition from the previous period. An appropriate inventory will potentially cause backorder as it delays for the next order, or oversupplied and high storage cost condition. Therefore, it required the optimal inventory management solution.

2. Methods
This study used the spare parts data of vehicle Mirage type from PT Y during January – February 2019 by considering uncertain demand, frequent backorder, and high order that cause the extra cost and customer unsatisfaction.

The steps conducted for this study were as follow: summarizing demand data and spare parts cost; conducting normal distribution test for class A data; determining demand pattern; calculating the optimal order (Q), reorder point (ROP), and safety stock (SS) by using Continuous Review method; calculating total inventory cost by using Continuous Review method.

3. Result and discussion
The data processing for spare part Disc FR Brake type by using Continuous Review method presented in table 1:

| Spare Part Name | Period       | Demand |
|-----------------|--------------|--------|
| Disc FR Brake   | January 2018 | 5.00   |
|                 | February 2018| 3.00   |
|                 | March 2018   | 0.00   |
|                 | April 2018   | 4.00   |
|                 | May 2018     | 0.00   |
|                 | June 2018    | 8.00   |
|                 | July 2018    | 0.00   |
|                 | August 2018  | 6.00   |
|                 | September 2018| 0.00 |
|                 | October 2018 | 7.00   |
|                 | November 2018| 3.00   |
|                 | December 2018| 4.00   |
| Total           |              | 40.00  |
| Deviation Standard |          | 2.87   |
| Average Demand  |              | 3.33   |

The demand model of spare parts for Disc FR Brake type presents in figure 1.
3.1. The Analysis of Spare Part Classification

The spare parts classification by using the ABC method conducted to indicate the priority level of spare parts by calculating the demand and sell price. The result presented in table 2.

| Classification | Spare Parts Amount | Percentages |
|----------------|--------------------|-------------|
| A              | 15                 | 80.09%      |
| B              | 19                 | 14.34%      |
| C              | 29                 | 5.57%       |
| **Total**      | **63**             | **100%**    |

The table shows that the spare parts in class A are the priority in the inventory stock as it has the most substantial infestation and should be available with highly regular control. The spare parts in class A conducted normal distribution test through demand data in class A by using the Kolmogorov Smirnov method. It results that from 15 spare parts in class A, only 7 quantities with appropriate normal distribution as it has significant value more than 0.05, thus only this amount qualified for the calculation for order, reorder, stock quantities, and total inventory cost by using Continuous Review method, as the result presented in table 3.
Table 3. Normal distribution test

| Spare Part Type       | Signification |
|-----------------------|---------------|
| Air Refresher         | 0.094         |
| Disc Front Brake      | 0.148         |
| Pad Set Front Brake   | 0.000         |
| Strut Front Susp.     | 0.200         |
| Disc Clutch           | 0.000         |
| Cover Assy. Clutch    | 0.200         |
| Bearing Clutch        | 0.200         |
| Shock Absorber        | 0.127         |
| Glass tailgate        | 0.000         |
| Air Refresh Assy.     | 0.000         |
| Control Unit          | 0.000         |
| Element Air           | 0.075         |
| Bearing Front Wheel   | 0.000         |
| Motor Cooling         | 0.000         |
| Blade Wind Shell      | 0.038         |

3.2. Inventory Planning Analysis

The demand decision presented in table 4 shows the demand variations for seven types of spare parts, along with the deviation standard of the average demand, and coefficient variants.

Table 4. Spare part demand decision

| Spare Part        | Deviation Standard | Mean | Coefficient Variants |
|-------------------|--------------------|------|----------------------|
| Air Refresher     | 67.97              | 59.30| 1.146                |
| Disc Front Brake  | 2.87               | 3.33 | 0.862                |
| Strut Front Susp. | 1.71               | 2.25 | 0.761                |
| Cover Assy Clutch | 1.71               | 3.00 | 0.569                |
| Bearing Clutch    | 2.67               | 4.25 | 0.628                |
| Shock Absorber    | 1.68               | 2.50 | 0.672                |
| Element Air       | 6.75               | 5.17 | 1.306                |

The data above obtains the coefficient variance higher than 20%, and demand data shows the demand spare parts variances are unable to continuously ordered, in the result that inventory planning model monthly tends to be probabilistic and varied. The optimal amount of order, reorder point, and safety stock by using the Continuous Review method presented in table 5.
Table 5. The proposed inventory planning

| Spare Part           | Service Level | Safety Factor | Quantity | Order | Reorder Point | Safety Stock |
|----------------------|---------------|---------------|----------|-------|---------------|--------------|
| Air Refresher        | 96            | 1.75          | 102      | 83    | 112           |              |
| Disc Front Brake     | 97            | 1.88          | 12       | 4     | 6             |              |
| Strut Front Susp     | 96            | 1.75          | 9        | 2     | 3             |              |
| Cover A Clutch       | 95            | 1.64          | 13       | 2     | 4             |              |
| Bearing Clutch       | 94            | 1.55          | 18       | 3     | 5             |              |
| Shock Absorber       | 94            | 1.55          | 15       | 2     | 3             |              |
| Element Air          | 91            | 1.34          | 22       | 6     | 8             |              |

3.3. The Comparison of Total Inventory Cost
To determine the total inventory cost by using the Continuous Review method affected by three components, which are order cost, supply cost, and backorder cost. The order cost affected by the amount of yearly demand and the optimal demand. The supply cost affected by the optimal demand cost and the safety stock cost. The backorder cost affected by the amount of yearly order, the optimal amount of demand, and the backorder expectation value. The differences between the total inventory costs applied by the company and applied method presented in table 6.

Table 6. The comparison of total inventory costs

| No  | Spare Part Type | Company’s Total Inventory Value (Rp) | Suggested Total Inventory Costs (Rp) |
|-----|-----------------|--------------------------------------|--------------------------------------|
| 1   | Air Refresher   | 4,599,614                            | 4,848,549                            |
| 2   | Disc FR Brake   | 7,817,200                            | 1,110,755                            |
| 3   | Strut RF SUSP   | 1,907,500                            | 995,629                              |
| 4   | Cover A Clutch  | 1,803,897                            | 959,119                              |
| 5   | Bearing Clutch  | 2,257,500                            | 901,833                              |
| 6   | Shock Absorber  | 3,291,020                            | 682,443                              |
| 7   | Element Air     | 1,120,632                            | 1,006,008                            |
|     | Total           | 22,797,363                           | 10,494,124                           |

4. Conclusion
The Continuous Review method able to used to determine the optimal order (Q), reorder point (ROP), and safety stock (SS) for seven types of vehicle spare parts for Mirage type on class A with a normal distribution. It shows the suggestion variation of inventory for spare parts, and each of them has different treatment. The inventory model for those seven types of spare parts is probabilistic and varied on each period. Hence, the order follows the inventory level according to the standard level. The comparison of total inventory cost by the suggested method results in the percentage of total inventory cost-saving up to 53.96% from the company’s overall inventory cost.
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