

SLOW MOVING ITEMS INVENTORY POLICY UNDER POISSON DISTRIBUTION DEMAND DESIGN IN YOGYAKARTA CENTRAL WAREHOUSE OF PT. KERETA API INDONESIA FOR MINIMIZING TOTAL RELEVANT COST INVENTORY USING CONTINUOUS REVIEW (s,Q) METHOD

Bernanda Tricahyo¹, Ari Yanuar Ridwan², Meldi Rendra³

^{1,2,3}Bachelor Program of Industrial Engineering, Industrial Engineering Faculty, Telkom University
¹bernandatrcmm@gmail.com, ²ari.yanuar.ridwan@gmail.com, ³merudivsk@yahoo.com

Abstract

PT. Kereta Api Indonesia (Persero), hereafter PT KAI (Persero) is the biggest railway industry in Indonesia, in terms of inventory, the company must be dealing slow moving item. As of 2015 the slow moving value worth IDR 70 billion and practically reached 0.8 million items. The suggested model continuous review (s,Q) under poisson distribution data over lead time was performed in one of PT KAI's central warehouses by using two-stage spare parts classification, Yogyakarta Central Warehouse (GPYK) that determines the optimal order size and reorder point to reduce annual total relevant cost (TRC) inventory along with CSL or cycle service level and fill rate. The percentage of reduced annual six SKUs TRC is up to 52% from existing TRC or gained to be exact IDR 4.1 million of savings, resulting the average percentage of CSL and fill rate as much as 98%.

Keywords: Slow Moving Item, VED Classification, Poisson Distribution, Continuous Review (s,Q), Cycle Service Level, Fill Rate, Total Relevant Cost TRC.

1. Introduction

The existence of inventory in daily activity cannot be avoided whether in personal activity, household, social, or business activity. Inventory can be categorized as working capital in goods form. Its existence can be considered as liability because it is a waste, but also can be asset that has cash value ^[1].

The term of inventory is usually used in business realm such in manufacturing. Inventory in a business organization can be categorized as capital in form of goods, most the inventory in railway industries type are spare parts, which consumes cost in holding inventory.

PT. Kereta Api Indonesia (Persero), hereafter PT KAI (Persero) or "Company", is a State-owned Enterprise that provides, organizes, and manages railways transportation services in Indonesia, PT KAI (Persero) operates the rail transportation services including passenger and freight. As the major operator of public railways in Indonesia, PT. KAI (Persero) has the largest infrastructures and facilities compared to other transportation services. To support the operational day-to-day, as of 2012, current PT KAI (Persero) have had facilities such as locomotives as much as 486 units, the units carriages 1716, hopper for goods transportation 6249 units, Electric Rail Train (KRL) 754 units, and a Diesel Railcar 166 units, while infrastructures such as rail road owned by PT KAI (Persero) were currently 2710 miles along Java Island and 1151.5 miles along the island of Sumatra. The condition of railway infrastructures and facilities requires treatment in order to support the operation of the railway, so the reability of facilities and infrastructures can sustain the company in serving customers/users.

According to data given by PT KAI, by 2015, total slow moving items reached 11,679 SKUs with the total number of 789.067 items that were worth IDR 69,9 billion. Tabel below shows comparison of cumulative total slow moving items value between 2010 and 2015.

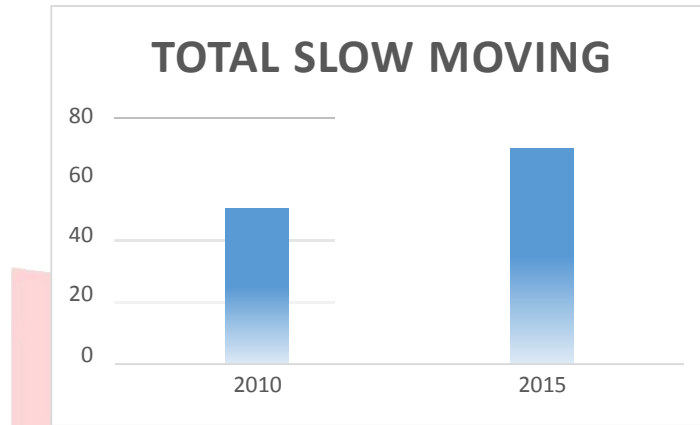


Figure 1 Slow Moving Value Yogyakarta Central Warehouse of PT KAI 2010 and 2015 (Source: PT KAI financial report)

The figure 1 above describes there was a slightly increase of slow moving items value, the worst case of keeping slow moving items for long period of time is categorizing them into scrap (dead inventory) which will be tendered with selling price no more than 10% of purchasing price. The data below presents the comparison of slow moving items value exists in GPYK (Yogyakarta Central Warehouse) of PT Kereta Api Indonesia and others warehouses.

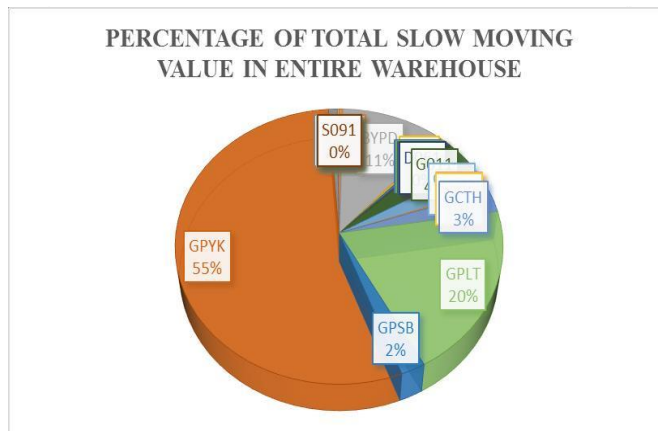


Figure 2 Comparison Slow Moving Value Percentage of Warehouses of PT KAI (Source: KAI financial report)

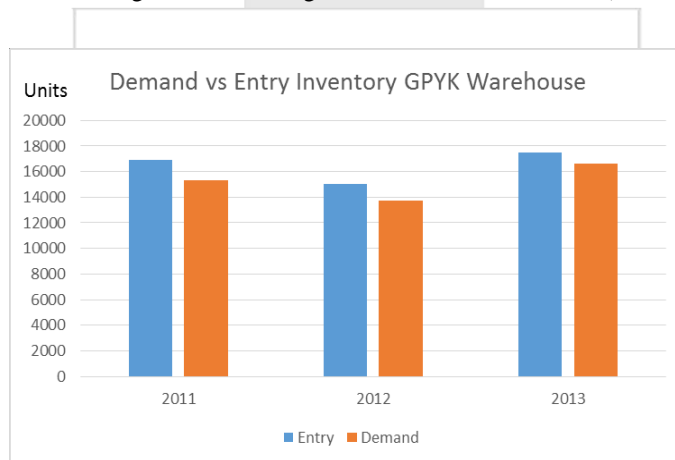


Figure 3 Demand vs Entry inventory of GPYK Warehouse (Source: Warehousing and Inclaring Manager of PT KAI)

Figure 2 represents the comparison of slow moving value percentages exist in all warehouses of PT KAI. GPYK warehouse has 55% of total slow moving value and it means GPYK has more slow moving item stored in its warehouse. Figure 3 shows that slow moving was caused by the difference between entry inventory and demand, the demand in that years was lower than ordered. Meaning, there were always overstocks.

2. Inventory Policy for Yogyakarta warehouse of PT KAI

Data needed in this research are demand of slow moving item, demand, stock, and price. Those data are then to be used as input for policy calculation. First, slow moving item data are classified into VED classification then V classification will be used to calculate total relevant cost inventory by using continuous review (s,Q) model. Expected output from calculation is inventory policy which is appropriate quantity, reorder point, total relevant cost inventory, cycle service level and fill rate.

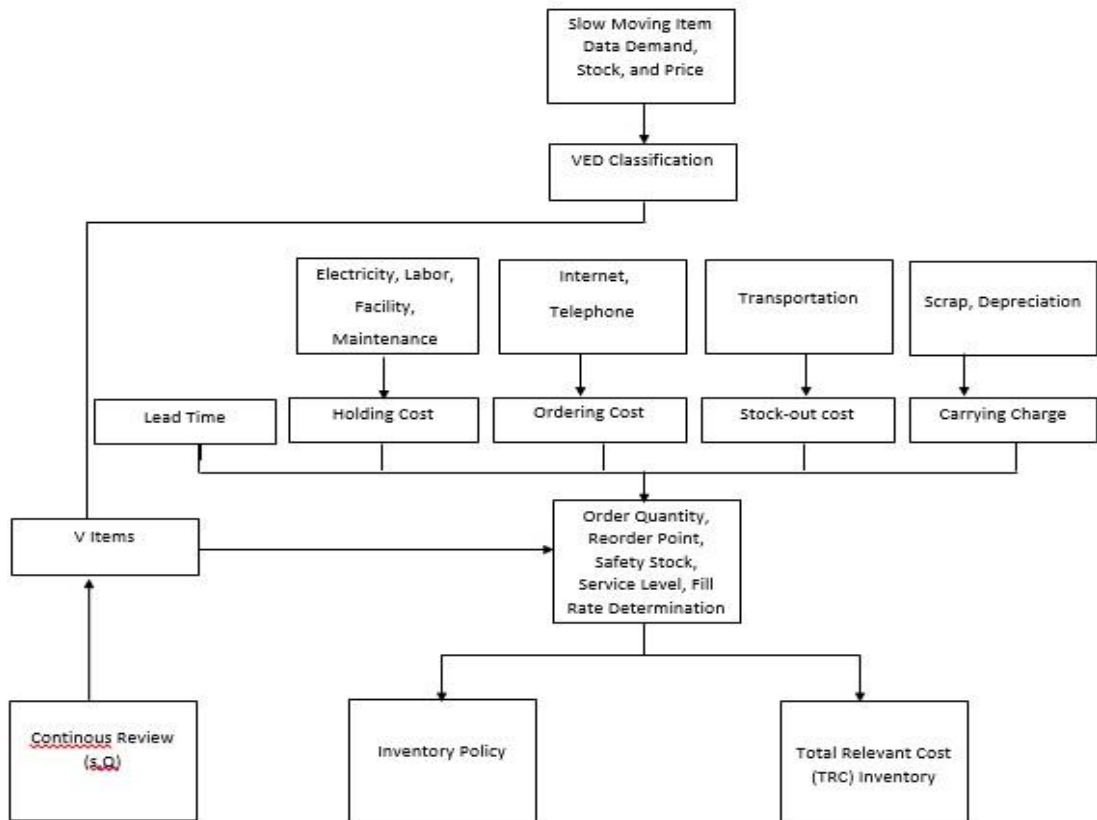


Figure 4 Conceptual Model of Research

2.1 VED Item Classification

The importance of managing vital inventory is really needed, classifying slow moving item data into VED can be done by the company. The result number of SKUs of each category as follows:

Table 1 Two-stage Item Classification

Total SKUs	VED (Vital Item)
488	139

2.2 Continuous Review (s,Q) Model

Parameter definition:

B1: Total stock-out costs which is caused by no supply of stock after failure of component.

H: Inventory holding costs per unit time for single spare parts. r: Internal interest rate.

V: Unit value.

D: Expected annual demand of spare parts.

L: Lead time

s: Reorder point

μ_L : Average demand in lead time.

A: Ordering costs for placing an order.

SS: Safety stock.

ES: Expected number of stock-outs in a cycle.

P: Probability.

Q: Order size.

Q*: Optimal order size.

σ : Standard deviation of annual demand distribution function.

P1: Service level which is the probability of not having a stock-out.

P2: Service level which is the fraction of demand to be satisfied routinely from shelf.

TRC: Expected annual total relevant cost.

1. Average Demand in Leadtime
determining how much of a year the LT represents

$$\mu_L = \frac{D}{365} \cdot L$$

So to get the average demand over the lead time, by summing up the average demand of each day of the LT. Since all the days are assumed to be the same and just multiply the daily average by the number of days.

2. Mathematical Model
Probability of an outcome of x when expected demand in lead time is variance.

1. Probability of an outcome of x when expected demand in lead time is variance:

$$P(X=x) = \frac{\mu^x}{x!} \cdot e^{-\mu}, \quad x \in \{0,1,2,3,4,\dots\}$$

2. Indifference between reorder point (s) and (s+1) when $Q > 1$:
For such a case the indifference useful for selecting appropriate reorder point. The case of $Q \geq 1$ and a cost structure, indifferent between s and s+1 as reorder points when

$$\frac{C_{o,s} + 1 \cdot C_{h,s}}{C_{o,s}} = \frac{C_{o,s+1}}{C_{o,s}}$$

$P(X = s+1) =$ Probability that a poisson variable with mean μ takes on the value s+1.

$P(X \leq s) =$ Probability that a poisson variable with mean μ takes on the value less than or equal to s

1. Carrying Charge

Carrying charge is a component in the formula for determining the order quantity. According to Johnsson (2005) the formula can be used to calculate the carrying charge.

$$C_{cc} = \frac{\sum_{s=0}^{Q-1} (Q-s) \cdot P(X=s) + \sum_{s=Q}^{\infty} (s-Q) \cdot P(X=s)}{Q}$$

2. Critical Ratio

According to theorem 3, for a given item, values of Q, V, r, D and B1 are used to evaluate the critical ratio CR. This is reorder point s corresponding to CR is the best value to use. Critical Ratio (CR) would be:

$$P_2 = \frac{P_1}{P_2}$$

3. Safety Stock

Safety stock equals to remaining stock for outcomes multiplied by corresponding demand probability. Therefore, safety stock is

$$SS = \sum_0^s (z - z^* P(z^*)), \quad z \in \{0,1,2,3,4, \dots\}$$

4. Expected Number of Stock-outs

If potential reorder point is more than determined reorder point there will be out of stock

$$ENSO = \sum_s^{\infty} (z - z^* P(z^*)), \quad z \in \{0,1,2,3,4, \dots\}$$

5. Total Relevant Cost (TRC)

Defined as annual total inventory cost that are relevant. The TRC be defined as below:

$$TRC = \frac{1}{2} \cdot C_o \cdot \frac{Q}{Q} + C_h \cdot \frac{Q}{2} + C_s \cdot ENSO > (C_h)$$

In order to find optimal order size Q, we can enumerate all possible Q and find corresponding annual total relevant cost.

6. Service Level P_1 and Fill rate P_2

Another important indicator is service level which is used to control the amount of inventory needed for satisfying customers' demand. P1 is often denoted as the probability of no stock-out during replenishment lead time, and P2 is denoted as the fraction of demand satisfied directly from the shelf (also called fill rate).

Service Level P_1

$$P_1 = 1 - P(z^*) > (C_h)$$

Service Level P_2

$$P_2 = 1 - \frac{ENSO}{Q}$$

SKU	Existing (IDR)	Suggested (IDR)	Saving (IDR)	% Saving
KIT6TAHUNAN_PACC201_190XCC201	Table 2 The Result of TRC 3421663.82	1362647.45	2059016.37	60%
KIT6TH_PACC201_190XCC201_1	666817.60	484002.11	182815.48	27%
KIT6TH_PACC201_190XCC202_1	1426725.48	804502.72	622222.76	44%
KIT6TH_PACC203_190XCC203_1	667137.07	614563.34	52573.73	8%
BATTERY_LOKOMOTIF_DIESEL_ELECTRIC	1168283.99	531625.95	636658.04	54%
GOVERNOR_ELECTRIC_CC201_GE7FDL8MFI	1051856.88	531625.95	520230.93	49%
Total	12,278.39	4,328,967.52	4,073,517.31	52%

3. Discussion

Data needed in this research are demand of slow moving and the price, VED classification data, lead time, holding cost, and order cost. Those data are then to be used as input for policy calculation. First, data of slow moving are classified into VED classification of V item will be executed with (s,Q) policy.

4. Conclusion

By using continuous review (s,Q), the improvement for 6 SKUs of V items is 52 % or IDR 4,073,517.31.

References

1. Molenaers, A., et al., Criticality classification of spare parts: A case study. *International Journal of Production Economics*, 2012. 140(2): p. 570-578.
2. Liuming, D., 慢速流动备件库存模型研究 Research on inventory model of slowmoving spare parts. 博士学位论文 Doctoral thesis, 华中科技大学 HuaZhong University of Science and Technology, 2006: p. 4-6
3. Dekker, R., M.J. Kleijn, and P.J. de Rooij, A spare parts stocking policy based on equipment criticality. *International Journal of Production Economics*, 1998. 56–57(0): p. 69-77.
4. Silver, E.A., D.F. Pyke, and R. Peterson, *Inventory management and production planning and scheduling*. 3 ed. Vol. 3. 1998, New York: John Wiley & Sons.
5. Pinçe, Ç. and R. Dekker, An inventory model for slow moving items subject to obsolescence. *European Journal of Operational Research*, 2011. 213(1): p. 83-95.
6. Johnston, F.R., J.E. Boylan, and E.A. Shale, An examination of the size of orders from customers, their characterisation and the implications for inventory control of slow moving items. *The Journal of the Operational Research Society*, 2003. 54(8): p. 833-833.