

# DETERMINATION OF INVENTORY PERIODIC REVIEW POLICY (R, s, S) USING POWER APPROXIMATION METHOD FOR MINIMIZE TOTAL INVENTORY COST IN PT. OPQ

Ratnawia<sup>1</sup>, Rio Aurachman<sup>2</sup>, and Saskia Puspa Kenaka<sup>3</sup>

<sup>1,2</sup> S1 Program of Industrial Engineering, Telkom University

<sup>3</sup>S1 Program of Industrial Engineering, Bandung Institute of Technology

<sup>1</sup> ratnawia1@gmail.com, <sup>2</sup> rioaurachman@telkomuniversity.ac.id, <sup>3</sup> saskia@itb.ac.id

Corresponding author: rioaurachman@telkomuniversity.ac.id

Received: 06 November 2018, Revised: 15 November 2018, Accepted: 23 December 2018, Published: 26 January 2019

**Abstract**— PT. OPQ is a company engaged in the automotive manufacturing industry. The company produces bolts for the safety area, it is related to the lower body of the four-wheeled vehicle. PT. OPQ was established in 2014 and today has already been the supplier for several major automotive companies in Indonesia. The demand of PT OPQ that must be fulfilled is increasing as the amount of consumer is increasing too. Due to the high demand, so the raw material stockout occurs. This make the company's service level is below the standard.

This study involved 48 sku of material raw materials that have normal distributed demand. Inventory policy applied in this research is periodic review (R, s, S) with the aim to minimize total cost of inventory and improve service level of company.

The result of this research was found to decrease total inventory cost by 15% with the value of existing inventory cost Rp1.100.879.479,- to Rp 936.061.349,- . In addition, service level at PT. OPQ has increased with the value of existing conditions 85% to 99%.

**Keywords**—Raw Material, Periodic Review, Probabilistic, Service Level, Stock out

## I. INTRODUCTION

PT. OPQ is an Indonesian privately held company located in Surya Cipta, Karawang industrial area that focused in automotive manufacturing industry. PT OPQ has built since 2011 and started to manufacture since 2014. This company produced bolt that used for safety part of in the lower body of four-wheels vehicle. PT. OPQ create a high quality bolt that has stable friction coefficient and anti-rust.

Since 2014, PT. OPQ has became the supplier for several giant automotive company in Indonesia. Because of that, PT. OPQ always maintain their product quality, well. One of factors that affects the bolt quality is the raw material used, steel coil that already tested for durability and raw material quality. Raw material is deformed in the first phase of product manufacturing that will be a final product. Based on that, the availability of raw material stock is crucial for the next process [5].

If PT. OPQ experienced stock out, it will affect the backorder cost, and the biggest effect is to the

corporate image. The other effect faced is getting pinalty from customer. Picture 1 shows the difference of inventory compared to demand of PT. OPQ in 5 months (August-December 2017).



**Figure 1** Comparison of inventory and demand

As seen in Picture 1, there is raw material stock out in August-December 2017. This caused by there is no inventory policy improvement for raw material although the number of customers are increasing and the amount of order is high. The effect from company's raw material stock out is the low service level of customer [2]. Picture 2 shows the condition of Service Level of PT. OPQ in August-December 2017 period.



**Figure 2** Service Level

There is a preliminary study that explain the raw material inventory policy for maintenance by Aditya (2009) [1] for minimizing inventory total cost. Besides that, there is also a preliminary study that explains inventory policy for accessories part by Paramaditya Arismawati (2015) [3] for minimizing inventory total cost using Periodic Review policy. Because of that, this research will discuss about the inventory policy periodic review (R,s,S) to increase the service level and minimize the total inventory cost of company.

II. LITERATUR REVIEW

2.1 Inventory

Inventory is all the resource owned by the company in the form of valuble things, it can be tangible or not. Inventory of a company can be sold, stored, or still in the process of finishing or waiting for another process [6]

Inventory control is an activity of managing the inventory with all the possible cost that will showed up [8]. Inventory control will be divided based on the fixed variable (deterministic) and the uncertainty (probabilistic). Inventory probabilistic model can happened when an inventory has uncertainty [4].

2.2 Periodic Review (R,s,S)

Inventory periodic review policy (R,s,S) is a policy that has demand pattern or leadtime of probabilistic, so the exact amount of demand and leadtime can't be determined. For periodic review inventory policy, inventory is controlled by time interval (R). Order for this policy is done based on the fixed period [5]. For periodic review inventory policy it involves three parameters that are interval review (R) that is review the review of company's inventory stock, maximum inventory (S) that is maximum amount that need to be fulfilled by the company, and reorder point (s) is minimum limit when company need to do re-order to fulfilled the minimum inventory amount [3].

2.3 Service Level

Service level is performance criteria that is difficult to be measured because it affected mostly by qualitative factors than quantitative [8].

$$\eta = \left(1 - \frac{N}{D(R + L)}\right) \times 100\% \tag{1}$$

Where

- $\eta$  : Service level
- N : Stockout
- $D(R + L)$  : Demand for interval review and lead time

2.4 Normality Test

Normality test is a standard preliminary test before making any further analysis . Data with normal distribution test result often used as the reason for several statistical test, even though not all data need to

be normal distributed One of normality test that can be used is kolmogorov-smirnov tes [9].

2.5 Conceptual Model

Conceptual model is a mind map that filled with problem solving framework and help the researcher to create a solution from the problem that is discussed. In general, here is the conceptual model that help the researcher to give proposed inventory policy of raw material in PT. OPQ :

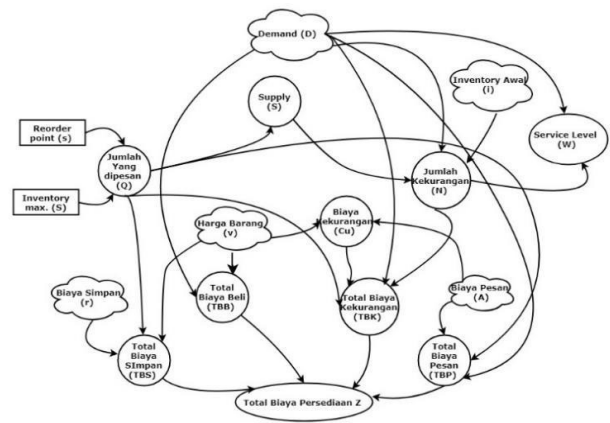


Figure 3 Conceptual Model

III. DISCUSSION

3.1 Data Distribution Test

In this research, normality test this done to recognize the PT. OPQ demand data distribution using Kolmogorov-Smirnov test in SPSS software [3]. The hypotesis for this research is as below [2]:

- Ho : Data is normally distributed.
- H : Data is not normally distributed.

Based on the hypotesis, the decision that can be taken are

- If Asymp.sig.(2-tailed) > 0,05, then Ho is accepted
- If Asymp.sig.(2-tailed) < 0,05, then H1 is accepted.

Here is the distribution tes result using SPSS software for 3 raw material

Table 1 SPSS Test result

	\$1010,6WDB	\$1010,1WDB	\$1012,15WKB
N	20	20	20
Normal Parameters <sup>a,b</sup>	172,3700	157,0550	174,3000
	18,99587	45,10613	16,33057
Most Extreme Differences	,134	,192	,187
	,109	,192	,187
	-,134	-,190	-,102
Test Statistic	,134	,192	,187
Asymp. Sig. (2-tailed)	,200 <sup>c,d</sup>	,053 <sup>c</sup>	,066 <sup>c</sup>

	S1010,6WDB	S1010,1WDB	S1012,15WKB
--	------------	------------	-------------

- a. Test distribution is Normal.
- b. Calculated from data.

Based on Table 1, it can be seen that distribution test result using Kolmogorov-Smirnov model with SPSS software is the average of Asymp. Sig(2-tailed) is above 0,05. Then, Ho is accepted and H1 is rejected.

### 3.2 Existing Inventory Cost Calculation

Total existing condition in the system of raw material inventory in PT. OPQ can be calculated by suming up all the cost with formula below [5].

$$O_T = O_p + O_s + O_k \tag{2}$$

Where

- O<sub>T</sub> : Inventory Total Cost
- O<sub>p</sub> : Holding Cost
- O<sub>s</sub> : Storing Cost
- O<sub>k</sub> : Stock out cost

**Table 3** Existing Inventory Total Cost

N O	Material	Op	Os	Ok	Or
1	S1010,6 WDB	Rp. 265.203.520	Rp. 2.008.675	Rp. 2.772.561	Rp. 17.312.284,67
2	S1010,1 WDB	Rp. 242.041.248	Rp. 2.231.862	Rp. 2.446.378	Rp. 24.938.959,50
3	S1012,15 WKB	Rp. 256.039.232	Rp. 2.120.268	Rp. 2.609.469	Rp. 29.440.930,64
4	S109,6W KB	Rp. 238.680.960	Rp. 2.231.862	Rp. 2.446.378	Rp. 20.821.181,60
5	S1014,8 WPB	Rp.255.877.200	Rp. 2.231.862	R. 2.772.561	Rp.16.343.230,20

### 3.3 Inventory Policy Calculation

Inventory policy periodic review (R,s,S) is a policy that has demand pattern of probabilistic. For periodic review inventory policy it involves three parameters that are interval review (R), maximum inventory (S), and reorder point (s).

#### 3.3.1 Interval Review Parameter Calculation (R)

Raw material S1010,1WDB is used as the

calculation example to find out the periodic review system parameter R (interval review) or T<sub>o</sub> that is most optimal using Hadley-Within method [5] Known :

- D : 3485,7 kg/ 5 month
- P : Rp 80.145
- A : Rp 55.797
- h : Rp 113.258/unit/5 month
- Cu : Rp 141.952/unit
- L : 0,2 month
- S : 16,319

Calculation :

ITERATION

1. Find T<sub>o</sub>

$$T_o = \sqrt{\frac{2A}{Dh}} \tag{3}$$

$$= \sqrt{\frac{2(55.797)}{(3485,7)(113.258)}} = 0,017$$

2. Find α and R

$$\alpha = \frac{T_o h}{Cu} \tag{4}$$

$$= \frac{(0,017)(113.258)}{141.952} = 0,0134$$

$$\alpha = 0,0134 ; z\alpha = 2,22 ; f(z\alpha) = 0,0338 ; \Psi(z\alpha) = 0,0337(\text{tabel})$$

$$R = D T_o + DL + Z(\sqrt{T_o + L}) \tag{5}$$

$$R = (3485,7)(0,017) + (3485,7)(0,2) + 2,22(\sqrt{0,017 + 0,2}) = 757 \text{ kg}$$

3. Find total inventory cost

$$N = S(\sqrt{T_o + L} \cdot [f(z\alpha) - z\alpha \Psi(z\alpha)]) \tag{6}$$

$$N = 16,319(\sqrt{0,017 + 0,2} \cdot [0,0338 - (2,22 * 0,0337)]) = 1 \text{ kg}$$

$$O_T = Dp + \frac{A}{T_o} + h(R - D.L + \frac{D.T_o}{2}) + (\frac{Cu}{T_o} \times N) \tag{7}$$

$$= 3485,7(80.145) + \frac{55.797}{0,017} + 113.258(757 - (3485,7 \times 0,2) + \frac{(3485,7 \times 0,017)}{2}) + (\frac{141.952}{0,017} \times 1)$$

$$= \text{Rp } 301.221.612,-$$

Do the iteration for parameter R by suming up and subtracting as the accuracy needed, then find the total minimum cost from every iteration.

Where

- D : Demand of raw material (unit/ month)
- A: Order cost of raw material (Rp)
- h: Holding cost (Rp/unit/month)
- Cu : Stockout cost (Rp/unit)
- S : Standard deviation
- T<sub>o</sub> : Order interval checking time
- L : Lead time (day)
- R : Maximum stock (unit)
- N: Stockout inventory (unit)
- α: Stockout inventory probability

3.3.2 Parameter Calculation (s,S)

Raw material S1010,1WDB is used as the calculation example. After the checking interval parameter has been found, the next step is to find the formulation of reorder point (s) and maximum level (S) [10].

Known

- D : 3485,7 unit
- L: 0,2 month
- S: 16,319 unit
- V: Rp 80.145/ unit
- A: Rp 55.797
- r: Rp 113.258/ unit.5month
- B3 : Rp 141.952 / unit
- R: 0,017 month

Here is the formulation of reorder point (s) and maximum level (S) using power approximation method

1. Initial calculation

$$X_R = RD = 0,017 \times 3485,7 = 58,604$$

$$X_{R+L} = (R+L)D = (0,017+0,2) 3485,7 = 755,744$$

$$S_{R+L} = (R + L) S = (0,017+0,2) 16,319 = 3,54$$

2. Find Q<sub>p</sub>, S<sub>p</sub>, dan z

$$Q_p = 1,3 X_R^{0,494} \left(\frac{A}{vT}\right)^{0,506} \left(1 + \frac{\sigma_{R+L}^2}{X_R^2}\right)^{0,116} = 1,3 (58,604)^{0,494} \left(\frac{55,797}{113,258}\right)^{0,506} \left(1 + \frac{3,54^2}{58,604^2}\right)^{0,116} = 7 \text{ kg}$$

$$S_p = (0,973 X_{R+L} + \sigma_{R+L}) \left(\frac{0,183}{z} + 1,063 - 2,192z\right) = (0,973(755,744) + (3,54)) \left(\frac{0,183}{1,26} + 1,063 - 2,192(1,26)\right) = 887,00$$

$$z = \frac{Q_p \cdot r}{\sqrt{(\sigma_{R+L}) B_3}} = \frac{7 \cdot (113,258)}{\sqrt{3,54 \cdot 141,952}} = 1,26$$

3. Menghitung nilai  $\frac{Q_p}{X_R}$

If  $\frac{Q_p}{X_R} > 1,5$

then, find the value of s and S, if not fulfilled then find the value of k.

If  $\frac{Q_p}{X_R} > 1,5$

$> 1,5$

Not fulfilled.

4. Find the value of k dan S<sub>o</sub>

$$p\mu \geq (k) = \frac{r}{r+B_3} \Rightarrow (k) = \frac{113,258}{113,258 + 141,952} = 0,44$$

$$S_o = (X_R + L) + k \cdot (\sigma_{R+L})$$

(14)

$$S_o = 755,744 + 0,44(3,54) = 758$$

5. Find the reorder point (s) and maximum inventory (S) as follows :

s = minimum {s<sub>p</sub>, S<sub>0</sub> }

s = minimum {730, 758 }

s = 730 kg

S = minimum {s<sub>p</sub> + Q<sub>p</sub>, S<sub>0</sub>}

S = minimum {730 + 7, 758}

S = 737 kg

Where :

R : Interval review time between order

D : Demand of masterial accessoris ( unit/ 5 month)

L : Lead Time (day)

r : Holding Cost (Rp/Rp/5 month )

B3 : Stockout cost (Rp/ unit)

A : Ordering Cost (Rp)

v : Raw material price (Rp/unit)

(9) SR+L : Standar deviation in interval review and lead time (unit)

+ : Average demand in interval review and lead time (unit)

: Average demand in interval review (unit)

Q<sub>p</sub> : Order quantity perspective (unit)

S<sub>p</sub> + Q<sub>p</sub> : Maximum(10)point (unit)

S<sub>0</sub> : Minimum point (unit)

≥ (k) : Stock out probability

(11)

Here are the calculation result of raw material with periodic review policy (R,s,S).

**Table 4** Result of parameter (R,s,S) in proposed condition (12)

NO	Material	PROPOSED		
		s	S	R (day)
1	S1010,6WDB	715	722	2
2	S1010,1WDB	663	670	2
3	S1012,15WKB	730,00	737,00	2



### 3.4 Calculation of Proposed Inventory Total Cost

After the parameter (R,s,S) has been found, the next step is find the total inventory cost [5] for every material. For example, material S1010,1WDB is used as calculation sample for proposed inventory total cost

**Table 5** Proposed Inventory Total Cost

N O	Material	Op	Os	Ok	Ot
1	S1010,6 WDB	Rp265.203.520	Rp3.300.421	Rp3.505.654	Rp7.630.638
2	S1010,1 WDB	Rp242.041.248	Rp3.150.390	Rp3.637.678	Rp17.521.646
3	S1012,15 WKB	Rp256.039.232	Rp3.318.704	Rp3.496.539	Rp6.443.718

### 3.5 Service Level Calculation

The calculation of service level is using microsoft excel with reorder point and maximum inventory data that has been found previously [5]. Demand data used is the historical data for the past 5 months (August-December) for material S1010,1WDB

Known

$$N = \sigma_{(R+L)} * gu(k) \tag{17}$$

$$N = 19,25 ( 0,0034+0,04) * 0,22 = 0,180$$

$$D = D_{(R+L)} \tag{18}$$

$$= 724 * (0,0034+0,04) = 31,423$$

Then, find the service level

$$n = 1 - \frac{N}{D_{(R+L)}} * 100\%$$

$$n = 1 - \frac{0,180}{31,423} * 100\% = 99\%$$

Based on the calculation above, the service level of the company is increased to 99%.

### 3.6 Discussion

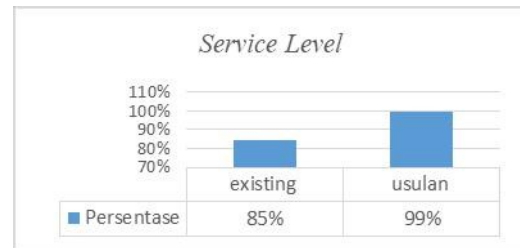
Based on the total supply cost calculation, the comparison of actual and proposed condition has been presented below



**Figure 4** Total cost comparison of actual and proposed condition

Supply cost is all the cost happened because of the amount of supply, it can be for the supply or opportunity cost [5]. Total supply cost as seen on Picture 4 is the total of all cost variable which are order cost, inventory cost, and stockout cost. The performance of total cost calculation is decreased as much as 29%. Total cost for existing is Rp. 3.213.687.864 becoming Rp. 2.285.091.765. This proves that with the implementation of periodic review policy (R,s,S) could minimize the total supply cost

Service level analysis will be compared with the service level of periodic review policy (R,s,S) implementation [7]. Here is the comparison graph of existing and proposed condition of service level in Picture 5



**Figure 5** Existing and proposed condition of service level percentage

Picture 5 shows the comparison of service level existing and proposed condition. The performance of service level in the proposed condition is increased to 100% while in the existing condition, the service level is only 72%. This happened due to the amount of raw material stockout affecting the company needs to take backorder decision for some raw material.

## IV. CONCLUSION

Problem that occurred in PT. OPQ is raw material stockout that affects the service level of company. Raw material stockout also affects the high cost of backorder that need to be paid. determine the periodic review policy (R,s,S) to minimize total supply cost. Based on the result, the total supply cost using periodic review policy (R,s,S) is Rp. 936.061.349 or 15% lower than total cost with the existing condition. This happened because the total order cost, inventory, and stockout is lower then the existing. Stockout reduction shows that the number of stockout products are decreased. The result of periodic review policy (R,s,S) implementation provides service level 99% or 15 % higher than the existing service level.

## V. REFERENCES

- [1] Aditya SP., W., Pujaman , I. N. & Kurniati, N., 2009. *Pengendalian Persediaan Spare Part dengan pendekatan Periodic Review (R,s,S) System*. Surabaya, s.n.
- [2] Arifin, J., 2017. *SPSS 24 untuk Penelitian dan Skripsi*. Jakarta: PT. Elex Media Komputindo.
- [3] Arismawati , P., Ridwan, A. Y. & Santosa, B., 2015. Perencanaan Kebijakan Persediaan untuk Meminimasi Total Biaya Persediaan dengan Pendekatan Metode Periodic Review (R,s,S) pada Part Aksesoris. *e-Proceeding of Engineering*, 2(2), p. 4877.
- [4] Assauri, S., 2008. *Manajemen Produksi dan Operasi*. Jakarta: Lembaga Penerbit Fakultas Ekonomi UI.
- [5] Bahagia, S. N., 2006. *Sistem Inventori*. Bandung: Penerbit ITB.
- [6] Baroto,T.,2002.*Perencanaandan Pengendalian Produksi*. Jakarta: Graha Indonesia.
- [7] Fauziah, S., Ridwan, A. Y. & Santosa, B., 2016 . Perencanaan Kebijakan Persediaan pada Produk Service Part Menggunakan Metode Periodic Review (R,s,S) System dan Periodic Review (R,S) System untuk Meningkatkan Service Level di PT. XYZ Cibitung. *Jurnal Rekayasa Sistem dan Industri* , III(04), pp. 66-71.
- [8] Haizer, j. & Render, B., 2015. *Manajemen Operasi : Manajemen Keberlangsungan dan Rantai Pasokan*. Jakarta: Salemba Empat.
- [9] Nurudin, M., Mara, M. N. & Kusnandar, D., 2014. Ukuran Sampel dan Distribusi Sampling dari Beberapa Variabel Random Kontinu. *Bimaster*, 03(1), pp. 1-6.
- [10] Silver, E. A., Pyke, D. F. & Thomas, D. J., 2017. *Inventory and Production Management in Supply Chain*. U.S.A: CRC Press.