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Proposed Implementation of an Integration Inventory Model to Supply Chain System involving Supplier, Manufacture and Buyer. (Study Case: PT. X)

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ABSTRACT

PT. X has the problem of how to maintain the stability of the costs charged to each party involved in the supply chain system. In order not to happen one party burden excess costs compared to the other party. The purpose of this research is to determine the optimal number of delivery frequency for customer; determine the optimal delivery quantity of the manufacturing for the customer; determining optimal quantity order from customer, optimal production quantity from manufacturing and optimal material order quantity for supplier; determining total cost of inventory on costumer, total inventory cost at manufacture and total total cost of optimal inventory. With the method used is the application of inventory model integrated in supply chain system involving suppliers, manufacturers and costumer. The results of research can be, the number of optimal delivery frequency is 52 times; The optimal manufacturing quantity delivery for costumer is 659 units; Order quantity of customer is 34,245 units, production quantity from manufacturing is 1,317 units and material order quantity for supplier is 1,317 units; and Total cost of inventory at costumer that is Rp. Rp 17,641,430, -, total inventory cost in manufacturing Rp 28.104.522, - and total cost Rp 45.536.792, -. Thus, if this inventory model can run successfully, will be able to reduce the total cost of inventory on the costumer of Rp. 338,142,997,50 can be saved by 95% to Rp 17,641,430, -, and for total inventory cost in manufacture from Rp 627,979,825.50 can be saved by 96% to Rp 28,104,522, - and the total total inventory cost from Rp 966.122.850, - can be saved by 95% to Rp 45,536,792.

Keywords: *Buyer, Manufacture, Supplier, Supply Chain, Material Conversion factor, delivery frequancy*

1. INTRODUCTION

Business competition today is no longer between companies. So the improvement of the company's internal management to win the business competition is no longer relevant. To answer the current business competition the company is competing to improve supply chain management to be more effective and efficient.

Conventional inventory management is deemed to be incompatible with current conditions. In addition to not in accordance with the spirit of partnership, conventional inventory management will cause distortion of information on the supply chain network resulting in the emergence of losses on one party in the supply chain. Supply management modes or models that can integrate multiple parties in the supply chain is necessary to minimize the occurrence of information distortion, so that can be generated synchronization of inventory management on the supply chain (Jauhari, *et al.*, 2009)..

PT. X is a contract manufacturing services that providing services to other companies / manufacturers (brand owners) to process products from Raw Material to Finished Goods. In running the business, raw material is bought by PT. X from a supplier that is selected by costumer and third party customer that is in service of product manufacture, raw material not bought but direct supply from costumer.

Based on these conditions, the problem will arise how to maintain the stability of the costs charged to each party involved, especially in the condition of the costumer first party, in order not to happen one party to bear excessive costs compared to the other party. Therefore, this research seeks to find the combined economic lot between suppliers, manufacturers and costumer

2. Literature Review

Traditional inventory management (EOQ and EPQ models) is considered unsuitable for review in the supply chain perspective. Therefore developing a inventory model that determines the combined lot involving multiple parties in the supply chain. Goyal (1976) is the first researcher to develop a Joint Economic Lot Size model. From the research that has been done Goyal got the result that with the lot of economic size can reduce the total cost in the supply chain significantly. Furthermore JELS ((Joint Economic Lot Size) inventory model originally developed by Goyal was then developed by several researchers.

Pujawan and Kingsman (2002) developed an integrated inventory model between the Supplier and the customer. This model assumes that f wants delivery from the manufacturer occurs in sending n for one time order is made. Furthermore the number of batches of production is m times of the shipment size. The result of this research is that synchronization of production and delivery time will reduce total supply chain cost. Chan and Kingsman (2005) developed the model of Pujawan and Kingsman (2002) into an integrated inventory model between multi-customer manufacturing. The resulting solution can reduce the total cost of supply chain that occurred. Kelle, Al khateeb and Miller (2003) add the cost of losing flexibility to the costumer as a result of the combined lot size determination on the model of Pujawan and Kingsman (2002). Until now the inventory model developed by Nyoman and Kingsman (2002) has not been integrated with material purchase. Therefore Jauhari (2006) tries to develop the model by integrating it with material purchase.

In inventory model from Jauhari (2006) every lot of order from Buyer (costumer) sent in n times of delivery in accordance with customer demand. Then the manufacturer will produce a number of m times the quantity delivered. Manufacturers will order materials of 1 / z times of production batches. So the relationship that happens is:

$$\mathbf{Q_b = nq} \qquad (2.1)$$
$$\mathbf{Q_v = mq} \qquad (2.2)$$
$$\mathbf{Q_m = Q\sqrt{z}} \qquad (2.3)$$

The calculation of total inventory cost at customer and manufacturing level in accordance with Pujawan and Kingsman (2002) supplemented with material inventory are:

$$TC_b = {}^{D}/_{nq}\,(A + Fn) + {}^{q}/_{2}\,h_b \; (2.4)$$
$$TC_v = {}^{q}/_{2}\,h_p((m-1) - (m-2)\,{}^{D}/_{P} + {}^{A_m rDz}/_{mq} + {}^{h_m mqD}/_{2Pzr} \qquad (2.5)$$
$$TC = TC_b + TC_v \qquad (2.6)$$

Where :
D = annual demand
P = annual production rate
Qb = order quantity from costumer
Qv = production quantity from manufacture
Qm = material order quantity
q = delivery quantity
K = production set up cost
A = costumer ordering cost
F = shipping cost
Am = material ordering fee
hb = cost of storage of finished product on costumer
hp = cost of storing finished products on manufacture
hm = material storage cost
n = number of delivery frequency
m = multiplication value Qv of q, integer value
1 / z = the division value Qm of Qv, integer value
r = value of material conversion to finished product
TCb = total cost of inventory on costumer
TCv = total inventory cost on manufacture

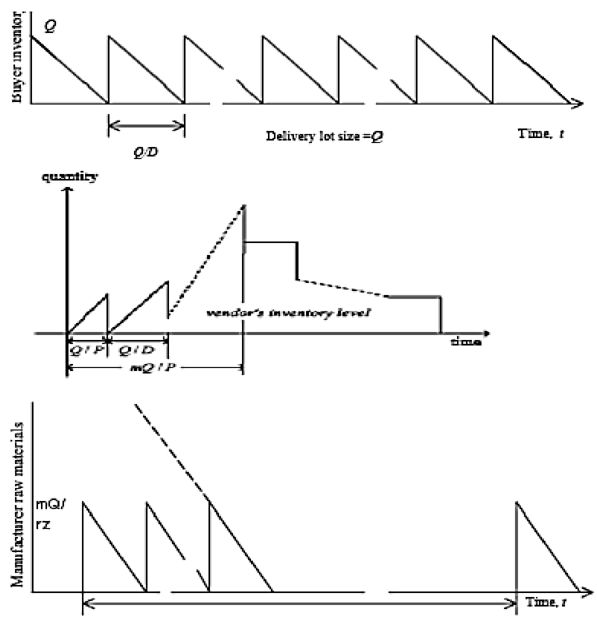

Fig. 1. Supply Level of Finished Products and Materials.

Size of the delivery lot size can be found by deriving the equation (2.6) to q, obtained:

$$\mathbf{q} = \sqrt{\frac{\frac{D}{n}(A+Fn)+\frac{DK}{m}+\frac{A_m rDz}{m}}{\frac{h_b}{2}+\frac{h_p}{2}\left\{(m-1-(m-2)\frac{D}{P}\right\}+\frac{h_m mD}{2Pzr}}} \qquad (2.7)$$

Then by entering equation (2.7) in equation (2.6) we will find the total cost of inventory equation:

$$TC = 2\sqrt{\left[\frac{D}{n}(A+Fn)+\frac{DK}{m}+\frac{A_m rDz}{m}\right]\left[\frac{h_b}{2}+\frac{h_p}{2}\left\{(m-1)-(m-2)\frac{D}{P}+\frac{h_m mD}{2Pzr}\right.\right.} \quad (2.8)$$

Values of m and z can be found by searching formulas:

$$TC(m^*) \leq TC(m^*-1) dan\, TC(m^*) \leq TC(m^*+1) \quad (2.9)$$
$$TC(z^*) \leq TC(z^*-1) dan\, TC(z^*) \leq TC(z^*+1) \quad (2.10)$$

From equations (2.9) and (2.10) found

$$m^*(m^*-1) \leq \frac{A_m rDz\left\{\frac{h_b}{2}+h_p\left(\frac{D}{P}-\frac{1}{2}\right)\right\}+\frac{h_b DK}{2}+DKh_p\left(\frac{D}{P}-\frac{1}{2}\right)}{\frac{D}{n}(A+Fn)\left\{\frac{h_p}{2}-\frac{h_p D}{2P}+\frac{h_m D}{2Pzr}\right\}} \leq m^*(m^*-1) \quad (2.11)$$

$$z^*(z^*-1) \leq \frac{\frac{h_m m^2}{2Pr^2 A_m}\left\{\frac{D}{n}(A+Fn)+\frac{DK}{m}\right\}}{\frac{h_b}{2}+\frac{h_p}{2}\left\{(m-1)-(m-2)\frac{D}{P}\right\}} \leq z^*(z^*+1) \quad (2.12)$$

The above issues can be solved by using the following algorithm:

1) Step 1 Set the value of z = 1 first
2) Step 2 Calculate the equation (2.11) with the z value and get the m value
3) Step 3 Compute the equation (2.12) with the m value obtained in step 2 and get the z 'value. If z = z 'then proceed to step 4. If z ≠ z' set z = z + 1 and return to step 2.
4) Step 4 Calculate q, Qb, Qv, Qm and TC with the values of m and z that have been obtained in the previous step

In this inventory model, the greater the frequency of deliveries made the smaller the total cost of inventory borne by the customer. With a large frequency of delivery then the costumer will tend to manage a smaller inventory that will reduce the cost of ordering. Meanwhile, if viewed from the manufacturing side, the greater the frequency of delivery will be the greater the cost incurred. With a large transmission frequency means that manufacturing is likely to have more inventory, so inventory costs will increase.

This inventory model has assumptions and constraints, either explicit or implicit, so relaxation can be done. Some suggestions that can be given for the perfection of future research, according Jauhari (2006) are as follows:

1. In this model the demand on the costumer is assumed to be deterministic. Whereas in the real condition, costumer will be faced with a fluctuative demand so that it is necessary to develop probabilistic inventory model.
2. In the above model lead time is worth 0. Whereas in the real case lead time will be fixed value or is a decision variable (controllable lead time).
3. The above model still considers that the production process can produce a product without defects. In the real case there is no production process that can always produce 100% good product. Therefore the above model can be developed into a model of inventory that takes into account the ability of the production process.

3. RESEARCH METHODOLOGY

Data divided into two namely primary data and secondary data. Primary data is the result of interviews with employees of PT. X. Secondary data is data obtained through documents owned by the company.

The method to be used is the Application of Supply Chain Model Integrated Supply Chain System Involving Supplier, Manufacturer and Costumer.

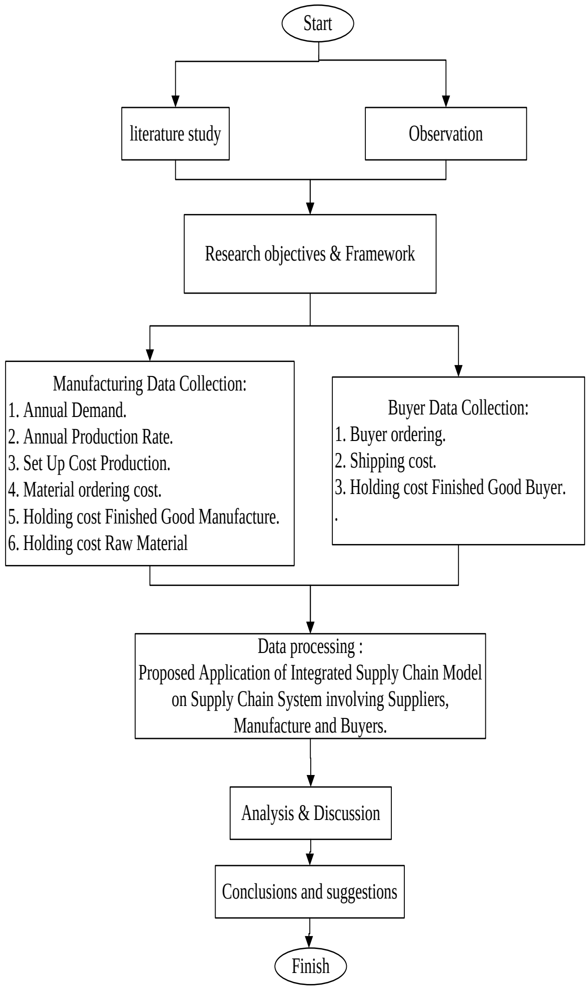

Fig. 2. The research flow diagram

4. Result and Discussion

From the results of data collection above, has been in the data - data that is needed for data processing are as follows:

D = 11,650 units / year
P = 16,200 units / year
K = Rp 322.041, - / set up
A = Rp 862.610, - / ordering
F = Rp 517.566, - / shipment
Am = Rp 1.207.654, - / ordering
hb = Rp 24.879, - / unit
hp = Rp 20.732, - / unit
hm = Rp 16.419, - / unit

In the calculation of inventory model after several attempted calculations, taken some calculations to be another consideration for the company that is for n (number of shipments) 10 (for small order quantities), 20 (for the number of orders approaching 2010), 40 slightly from the suppliers' desire) of the 48, (suppliers desire) 52, 56 (craving costumer) and 60 (sending more of the customer's wish)

Based on the calculation of inventory model with n (shipping quantity) that is 10, 20, 40, 48, 52, 56 and 60 as seen in Table 1 as follows:

Tabel 1. Calculation Result

n	10	20	40	48	52	56	60
m	2	2	2	2	2	2	2
z	1	1	1	1	1	1	1
q	676	665	660	659	659	658	656
Q_b	6.761	13.306	26.393	31.627	34.245	36.862	39.479
Q_v	1.352	1.331	1.320	1.318	1.317	1.317	1.316
Q_m	1.352	1.331	1.320	1.318	1.317	1.317	1.316
TC Buyer	18.815.109	18.094.354	17.726.914	17.665.202	17.641.430	17.621.036	17.603.350
TC Vendor	28.147.199	28.118.747	28.106.990	28.105.198	28.104.522	28.103.950	28.103.457
TC Total	46.962.308	46.213.101	45.833.905	45.770.400	45.745.952	45.724.985	45.706.807

From the interviews in the can customer and suppliers (suppliers) want more orders than the current period. Costumer and suppliers also want the number of shipments (n) is not much different from the previous year so as not to drastically change the production schedule of suppliers and the schedule of taking goods on costumer. So the researchers proposed that the number of shipments (n) be made as much as 52 times either for suppliers intended for manufacturing or for mmanufaktur intended to meet orders from customer

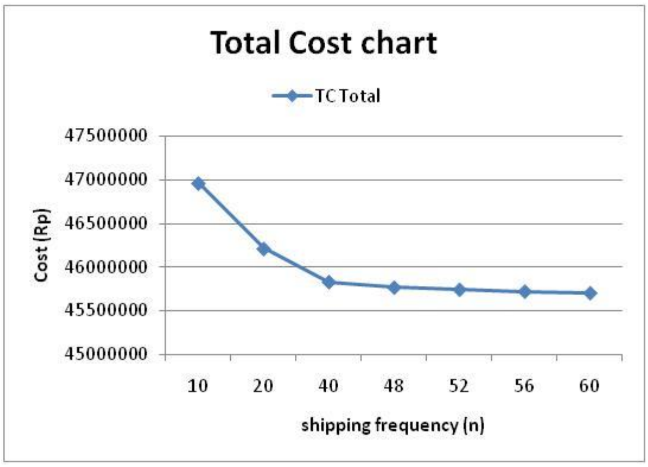

Fig. 3. Total Cost Chart

Inventory model can decrease total cost of inventory at costumer that is from Rp. 338,142,997,50 can be saved by 95% to Rp 17,641,430, -, and for total inventory cost in manufacturing from Rp 627,979,825.50 can be saved by 96% to Rp 28,104,522 and the total total inventory cost from Rp 966.122.850, - can be saved by 95% to Rp 45,536,792.

5. Conclusion

Based on the results of data processing and analysis, it can be concluded as follows:

1. The optimal number of delivery frequency for customer is 52 shipping.
2. The optimal delivery quantity from manufacturing to costumer is 659 units.
3. Order quantity of costumer is 34,245 units, production quantity of manufacture is 1,317 units, and material order quantity for supplier is 1,317 units.
4. Total cost of inventory at costumer is Rp. Rp 17,641,430, -, total inventory cost in manufacturing Rp 28,104,522, - and total cost Rp 45,536,792 -

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