Managing Inventory for perishable product, sensitivity analysis for product 'X' and suggestion for appropriate purchase model for a local retail shop "SHWAPNO"

Moddassir Khan Nayeem,AshikTakvir, Md. Robiul Islam

Abstract- This report has been prepared on 'Managing Inventory for perishable product, sensitivity analysis for product 'X' and suggestion for appropriate purchase model for a local retail shop "SHWAPNO" ' which is under the company ACI Logistics Ltd. The one core part of the report contains Inventory flow from Distribution Centre to Retail Stores including the focus complexity management and physical management of thousands of SKU (stock keeping unit) in whole chain. As Shwapno handles more than 30000 SKUs including perishables like Vegetables, Fish and Meat, Grain (VFMG) so it become the most challenging to manage inventory supply for Shwapno. Finally efforts have been made to recommend certain issue for further business process improvement like how to cost effectively managing inventory. It is also suggested from report analysis that present purchase cost is at higher side which needs to be addressed to make the business profitable.

Index term - Inventory, EOQ, sensitivity analysis, purchase model, carrying cost, ordering cost, holding cost, demand

1. Introduction

Proper inventory system and distribution system directly make a positive impact on any industry. On the other hand improper inventory system make a negative impact. In a country like Bangladesh their many company who are not following any economic order quantity model, purchase model, in a word there is no proper inventory system. Because of lacking expertise many industries are running without following proper inventory system.

There are some successful industries which are following proper inventory system and that is why they are successful industries. As project work we were assigned to "Shwapno", which is a retail shop and we found that they are not maintain inventory system properly. Their economic order quantity was not maintained properly. This project work will cover inventory management strategy from ordering, receiving and supply of the stocks to the outlets. It also covers different mode of transportation cost, distribution cost and its impact of business. A force will be made to identify the bottom necks in managing inventory in retail chain and procured some suggestion from improvement.

2. Result and Discussion

2.1. Problem statement of Shwapno:

Usually Shwapno purchase perishable products from a local market at a wholesale price which creates some drawbacks regarding inventory management. They are-

- No specific time gap between successive orders results over storage and so preservation cannot be provided to these items.
- Stores having small inventory often face product shortage as no fixed reordering time is given
- Due to traffic it may not be possible to deliver perishable items in time in their best condition.
- No specific average order quantity results uncertainty among suppliers.
- All these problems makes it impossible to trace consumer demand for a certain outlet
- Total cost drastically increases when cost per unit increases which need to be controlled
- Their current purchase model is not cost effective regarding total annual cost of inventory

2.2 Solutions for above mentioned problems

EOQ model for perishable product (Beef) [2]

As Shwapno do not following any economic order quantity model (EOQ) for perishable item right now that is why we suggest an economic order quantity model. Where all inventory decisions are then made centrally based on this information. In the pull system, however, the inventory decisions are made by local managers based on their local conditions. [3]

In the table 2.1 carrying cost is described in terms of rental for animal peen/shed, caretakers wages and cattle feed

TABLE 2.1: CARRYING COST

Cost	Amount(BDT)	Cost description
Rental for annual penn/shed	786000	Tk40/ Sq. Ft./ month* 32 Sq. Ft./ Cattle*50 cattle (carrying capacity of the penn)*12 months
Caretaker wages	456250	Tk 250/ caretaker/day*5 persons*365 days
Cattle feed	912500	Tk 50/cattle/day*50 cattle*365 days
Annual total carrying cost	216750	For 50 cows

Annual carrying cost per kg =356.13(Storage capacity of the penn = 50 cows; weight of 1 cow = 120 kgs)

TABLE2.2: ORDERING COST

Cost	Amount(BDT)	Cost Description
Hashil& commission	14400	Tk600/ cattle*24 cattle/ truck
Caretaker cost	800	Tk 400/ 12 cattle*24/12
Inbound transportation cost	15000	Tk12000/ truck
Ordering cost/ order	30200	where 1 order = truckload

Annual Demand=1512000 kg (48 outlets* 105 kg per outlet per day*300 days in a year)
EOQ = [(2* Annual demand *ordering cost)/Annual carrying cost] ^0.5
= [(2*1512000*30200)/356.13]^0.5
=16014kgs
No of order per year = 1512000/16014= 95
Average QTY ordered per store per order =16014/48 = 334kgs
Time gap between successive orders (In days) =365/95=3.8days

Sensitivity analysis

For total cost, the formula TC $=k.\frac{D}{Q}+h.\frac{Q}{D}+DC$

Here we get 5 variables. Where D = demand, C= cost/unit, Q=quantity, K=fixed cost, h=holding cost. Now the standard value of those variables are 70, 40, 20, 80 and 10 respectively.

Now TC = (70.2) + 10. (20/40) + (40*80) = 3345 BDT

TABLE 2.3: GRADUAL COST INCREASE FOR VARIABLES

Variables	Basic value	15% increase	20% increase	25% increase	30% increase	35% increase	40% increase
K	70	80.5	84	87.5	91	94.5	98
D	40	46	48	50	52	54	56
Q	20	21.5	22	22.5	23	23.5	24
C	80	92	96	100	104	108	112
h	10	11.5	12	12.5	13	13.5	14

The variables were increased 5% from 15% up to 40% and the increased value of the variables are shown in the table.

TABLE 2.4: COMPARISON OF COST BETWEEN INCREASED VALUES OF VARIABLES

Variables	Increased value	Total cost due to increased value 0f the variables	Amount of change for 5% increase of variables
K	80.5	3366	6
	84	3373	
	87.5	3380	
	91	3387	
	94.5	3394	
	98	3401	
D	46	3845	167
	48	4012	
	50	4179	
	52	4345.8	
	54	4512.7	
	56	4679.5	
Q	21.5	3335.6	(2.4~2.9)
	22	3332.7	
	22.5	3330	
	23	3327.5	
	23.5	3324.9	
	24	3322.6	
C	92	3825	160
	96	3985	
	100	4145	
	104	4305	
	108	4465	
	112	4625	
h	11.5	3345.8	.25
	12	3346	
	12.5	3346.25	
	13	3346.5	
	13.5	3346.8	

After the increase of the values of variables, total cost increases for K, D, C and h. But for the increase of Q total cost decreases.

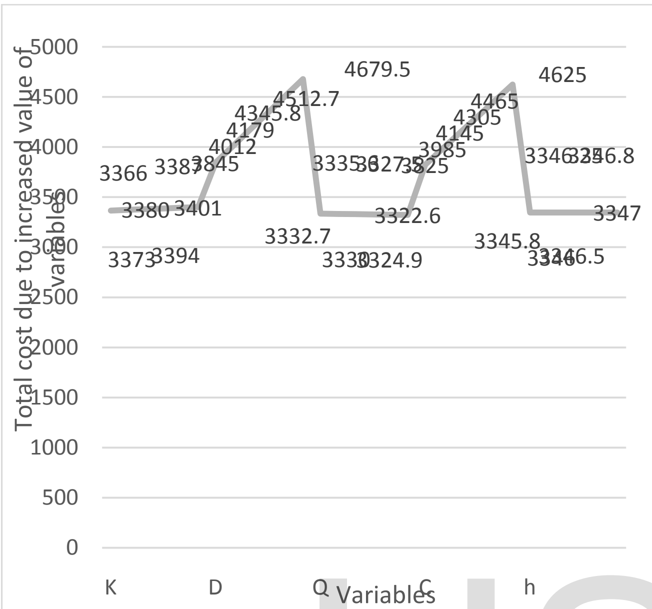

Figure 2.1: Graph of Total cost versus Variables

Here we can see that value of total cost increases drastically for D and C. so if variable D and C can be controlled or lessened then total cost will be reduced. So we can say D and C are the most sensitive variables among five of them.

Demand can vary time to time so only variable that is left is cost per unit. In order to decrease cost per unit we need to purchase in a large quantity.

Now we have to determine which purchase model is appropriate for 'SHWAPNO' .

Purchase Model

Model I: Purchasing Model without Shortage

Assumptions: Demand is known, purchasing at equal interval, zero lead time, no shortages and instantaneous replenishment. [1]

The corresponding model is shown in Fig. 1.1

Let D = annual demand

c1 = holding cost/unit/year and time horizon = 1 year.

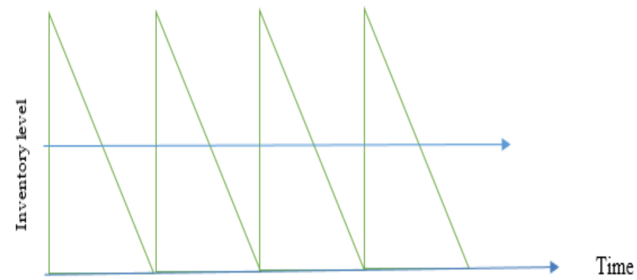

Fig. 2.2. Purchase model without shortage

Total inventory over the time period t = Area of the first triangle

= ½ Q.t

Average inventory at any time = (1/2 Q.t) / t = 1/2Q

Total cost = Ordering cost + Holding cost + Purchase cost (constant)

Minimize TC (Q) = cs. D / Q + c1 1/2 .Q +Constant

Minimize TC (Q) = $c_s \frac{D}{Q} + c_1 \frac{1}{2} Q$

We apply Calculus method: $\frac{dTC(Q)}{dQ} = 0$ & $\frac{d^2\,TC(Q)}{dQ^2} > 0$

$\frac{dTC(Q)}{dQ} = 0$

$$- c_s \frac{D}{Q^2} + c_1 \frac{1}{2} = 0$$

$$Q^2 = \frac{2c_s D}{c_1}$$

$$Q = \sqrt{\frac{2c_s D}{c_1}}$$

$\frac{d^2\,TC(Q)}{dQ} = \frac{2c_s D}{Q^3} > 0$ At $Q = \sqrt{\frac{2c_s D}{c_1}}$

Hence optimum EOQ is $Q^* = \sqrt{\frac{2Dc_s}{c_1}}$

$TC^*(Q) = c_s . D. \sqrt{\frac{c_1}{2Dc_s}} + \frac{1}{2} . c_1 . \sqrt{\frac{2c_s D}{c_1}}$

$c_A = \sqrt{2c_1 c_s D}$

Time between orders

T* = Q*/ D

n* = optimum number of orders placed per year

= D / Q*

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Note. If the holding cost is given as a percentage of average value of inventory held, then total annual holding cost,

c1 = c * 1, where

c = unit cost 1 % of the value of the average inventory.

In Shawpno Company purchases in lots of 2000 items which is a

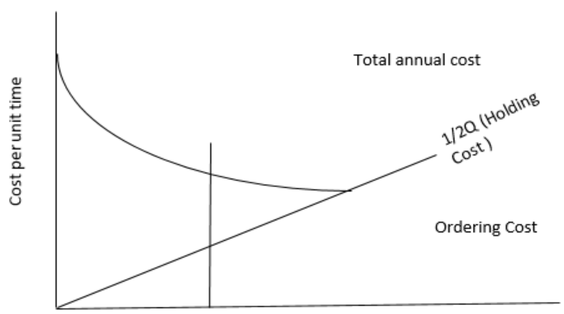


Fig. 2.3: Cost model

12 month supply. The cost per item is Tk.80 and the ordering cost is Tk.500. The inventory carrying cost is estimated at 20% of unit value.

Here,

Given Cs = Tk. 500

Number of items per order = 500

Annual demand, D = 2000

C1 = Procurement price x inventory carrying cost per year

= 80 * 0.20 = Tk. 16

$Q^* = \sqrt{\frac{2Dc_s}{c_1}} = \sqrt{\frac{2 \times 2000 \times 500}{16}} = 353$

Total annual cost of the existing inventory policy = D/Q. cs + Q/2.c1

= 2000/353*500+353/2*16

= Tk.5657

Model II: Purchasing Model with Shortage

Assumptions: All the assumptions of model I except shortage occurs here. Backlogs due to shortage to be met with penalty.

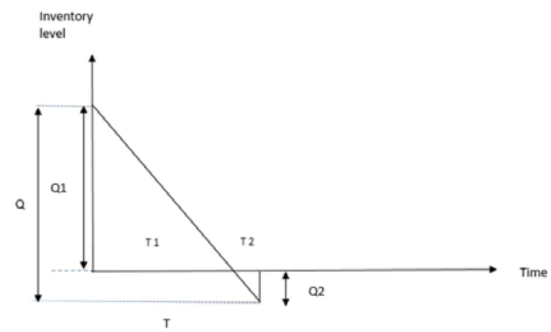
One inventory cycle is given in the Fig. 2.4.

During time period t1 inventory exhaust and during time period t2 shortages developed.

Here,

Q 1 = Actual inventory in hand.

Fig 2.4. Purchase model with shortage



Q2 = Shortage/Stock out

Q = Q 1 + Q2, t = t 1 + t2 = cycle time.

Total cost = Holding cost + Ordering cost + Shortage cost

$Q^* = \sqrt{\frac{2c_sD}{c_1} \cdot \frac{c_1 + c_2}{c_2}}$

$Q_1^* = \sqrt{\frac{2c_sD}{c_1} \cdot \frac{c_2}{c_1 + c_2}}$

$Q_2^* = Q^* - Q_1^*$

$t^* = \frac{Q^*}{D}$, $n^* = \frac{D}{Q^*}$, $t_1^* = \frac{Q_1^*}{D}$, $t_2^* = \frac{Q_2^*}{D}$

The optimum values are given as Total optimum cost = $\sqrt{2Dc_sc_1 \cdot \frac{c_2}{c_{1+c_2}}}$

In Shawpno the demand for a certain item is 2000 units per year. Unsatisfied demand causes a shortage cost of Tk.80 per unit per short period. The ordering cost for purchase is TK. 700 per orderand the holding cost is 20% of average inventory valuation per year. Item cost is 70 per unit.

Here,

D = 2000 units/year

c2 = 80/unit/shortage period.

c5 = Tk. 700

c1 = 70 x 0.2 = Tk. 14/unit/year.

$$Q^{*} = \sqrt{\frac{2c_sD}{c_1} \cdot \frac{c_1 + c_2}{c_2}} = \sqrt{\frac{2\times80\times2000}{14} \cdot \frac{94}{80}} = 164 \text{ units}$$

$$Q_2^{*} = Q^{*} - \sqrt{\frac{2c_sD}{c_1} \cdot \frac{c_2}{c_1+c_2}}$$

= 164 - 139 = 25 units

$$\text{Total minimum cost} = \sqrt{2Dc_sc_1 \cdot \frac{c_2}{c_{1+c_2}}}$$

$$= \sqrt{2 \times 2000 \times 700 \times 14 \times \frac{80}{94}}$$

= Tk. 5776 > 5657

As total cost is less in Model 1 (Purchase model without shortage); so Model 1 is recommended.

3. Conclusion

The efficiency of a retail store is based on the retailer's ability to provide the right goods to the consumer, in the right quality, in the right quantity, at the right place and in right time. The entire process of retailing depends on the efficient inventory management. Inventory management is one area that differentiates successful and unsuccessful retail stores.

EOQ model or known as economic order quantity model is the order quantity that minimizes the total holding costs and ordering costs. It is one of the oldest classical production scheduling models. This model can be used in managing inventory regarding perishable items as well as their preservation. Which will reduce extra inventory holding cost and ordering cost. By EOQ model we have calculated optimum number of order per year, time gap between successive orders, But currently Shwapno is not maintaining EOQ model that is why there is no optimum number of order per year, they have no control on inventory cost, sometimes their product get waste and they are in short of product as well though customer is available.

.Appropriate purchase model will help Shwapno to reduce the inventory carrying costs. The minimum level of inventory are notmaintained at different centers but at centralized center which reduce investments in inventories along with the other incidental storing costs. The central buying staff manages the stock levels, recording material usage, lead time and prices effectively.

4. References

[1] Heizer and Render, "Operation Management", 9th Edition, Pearson Education Inc., USA, Vol- 3,pp 454-456

[2] EOQ model Harris, Ford W. (1990) [Reprint from 1913]. "How Many Parts to Make at Once"

[3] A.Federgruen, Centralized planning models, in: L.B. Schwarz (Ed.), Studies in Management Sciences, vol. 16, Multi-Level Production/Inventory Control Systems, North-Holland, Amsterdam, 1993, pp. 133—173

- *Moddassir khan Nayeem has currently completed graduation in Industrial and Production Engineering from Ahsanullah University of Science and Technology, Dhaka, Bangladesh. Email- mknayeem.ie@gmail.com*
- *AshikTakvir has currently completed graduation in Industrial and Production Engineering from Ahsanullah University of Science and Technology, Dhaka, Bangladesh.Email-ashikaustipe@gmail.com*
- *Md.Robiul Islam is doing his masters of engineering in Advanced Engineering Management at Bangladesh University of Engineering and Technology, Dhaka, Bangladesh. Email-robiulislamipe@gmail.com*