Inventory Reduction using Analytic Hierarchy Process in an Automotive Industry

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Abstract

The main objective of this paper is to present about a model which was developed for finding the total inventory cost for a leading two wheeler manufacturer in south India. The model was developed using basic Economic Order Quantity (EOQ) model. The data for past five years were collected from the industry and a program was developed using Visual Basic to make use of least square method to generate Total Inventory Cost (TIC) for every year for the company using Least Square method. Various lean tools have been applied in order to reduce Total Inventory Cost (TIC) where Analytic Hierarchy Process (AHP) has been used, the details of which are presented in this paper.
Keywords: Economic Order Quantity (EOQ), Least Square Method, Analytic Hierarchy Process (AHP)

I. INTRODUCTION

In today's competitive world paying attention to customer and making production regarding customer is an important beginning but when all the companies do the same, produce what customer wants, then the competition starts in area of production and the one who is better in quality, faster in delivery, cheaper and more agile wins the competition. So to be better in manufacturing area lean production is a way with its easy to use tools. Production time is one of the main factors to provide the objects to achieve competitiveness. Also effective use of work area provides employee motivation and satisfaction.

This paper will purvey a better understanding of lean concept and also it will help the companies to become leaner and it will help the companies to realize the difference after becoming lean by providing measures of improvement.

Presently the inventory cost of the company is more due to the drastic variation in the customer demand. Also the maintenance of inventory needs more space and consumes more cost.

II. ECONOMIC ORDER QUANTITY MODEL (EOQ)

In this model inventory is ordered from an outside supplier.
Assumptions of EOQ model,

- Demand is constant
- Lead-time is constant
- Order cost is constant and independent to the quantity ordered
- Quantity ordered is constant

$$TIC = OC + HC$$

TIC – Total Inventory Cost
OC - Ordering cost incurred each time stock are reordered
HC – Holding costs proportional to average stock holdings Inventory

A. Ordering Costs

$$OC = C_0 * \frac{D}{I}$$

Where,
C_0 is the cost of placing each order
I is the size of inventory order placed
D is the annual demand for the inventory item

B. Holding Costs

$$HC = C_h * \frac{I}{2}$$

$$HC = C_p * P * \frac{I}{2}$$

Where,
C_h is the cost holding each unit of inventory
C_p is the cost as a proportion of the inventory value
P is the purchase price of the inventory
Since

$$TIC = OC + HC$$
$$TIC = C^0 * \frac{D}{I} + C_h * \frac{I}{2}$$
$$= C^0 * \frac{D}{I} + C_p * P * \frac{I}{2}$$

III. FORECASTING

Forecasting activities are a function of (1) the type of forecast (e.g., demand, technological), (2) the time horizon (short, medium, or long range), (3) the database available, and (4) the methodology and relationships, with an allowance for random components. Forecasts for groups of products tend to be more accurate than those for single products, and short-term forecasts are more accurate than long-term forecasts (greater than five years). Quantification also enhances the objectivity and precision of a forecast.

A. Least Square Method

Least square is a mathematical technique of fitting a trend to data points. The resulting line of best fit has the following properties: (1) the summation of all vertical deviations about it is zero, (2) the summation of all vertical deviations squared is a minimum, and (3) the line goes through the means X and Y bar.

$$\sum Y = na \qquad a = \sum Y / n$$
$$\sum XY = b \sum X^2 \quad b = \sum XY / \sum X^2$$

To code the time series data, designate the center of the time span as X = 0 and let each successive period be ±1 more unit away.

Table – 1
Input Data

Year	*cost of placing each order, Co*	*size of inventory order placed, I*	*demand for the inventory item, D*	*Cost of holding each unit of inventory, Ch*
2005	*95000*	*4350*	*52000*	*930*
2006	*103000*	*4380*	*52500*	*965*
2007	*119000*	*4430*	*53100*	*980*
2008	*123000*	*4510*	*53900*	*996*
2009	*126500*	*4530*	*54200*	*1010*

Table – 2
Least Square Method

Year	*X Year Coded*	*Y TIC (Rs)*	*XY*	*X^2*
2005	*-2*	*3158382.18390805*	*-6316764.3678161*	*4*
2006	*-1*	*3347939.04109589*	*-3347939.04109589*	*1*
2007	*0*	*3597088.26185102*	*0*	*0*
2008	*1*	*3715980*	*3715980*	*1*
2009	*2*	*3801182.00883002*	*7602364.01766004*	*4*
Total	*0*	*∑Y =17620571.49568498*	*∑XY= 1653640.60874805*	*$\sum X^2$ =10*

a=∑Y / n = 3524144.299136996
n=5
b=∑XY / $\sum X^2$ = 165364.060874805
Y = a + b X
Y = 3524144.299136996 + 165364.060874805 X

Table – 3
Forecasted Inventory Cost Values

Year	*X*	*TIC, Rs*
2010	*3*	*4020236.481*
2011	*4*	*4185600.542*
2012	*5*	*4350964.603*
2013	*6*	*4516328.664*
2014	*7*	*4681692.725*

IV. ANALYTIC HIERARCHY PROCESS (AHP)

AHP deals with complex, unstructured and multi-attribute decision problems. The application of AHP is widely accepted in various areas such as operation management, manufacturing, economics, business, and information technology. With its ability to mimic human opinions in structuring a complex and multi-attribute problem, AHP has significantly improved the performance of the decision-making process in organizations.

Table – 4
Reciprocal Matrix & Comparison Matrix

Factors	*Over Production*	*Waiting*	*Unwanted Motion of Operator*	*Over Processing*	*Transportation*
Over Production	*1*	*5*	*4*	*5*	*7*
Waiting	*1/5*	*1*	*3*	*5*	*1/5*
Unwanted Motion of Operator	*¼*	*1/3*	*1*	*1/3*	*3*
Over Processing	*1/5*	*1/5*	*3*	*1*	*1/5*
Transportation	*1/7*	*5*	*1/3*	*5*	*1*
Sum	*1.39*	*11.53*	*11.33*	*16.33*	*12*

Table – 5
Normalized Matrixes

Factors	*Over Production*	*Waiting*	*Unwanted Motion of Operator*	*Over Processing*	*Transportation*
Over Production	*0.72*	*0.43*	*0.35*	*0.3*	*0.58*
Waiting	*0.14*	*0.09*	*0.26*	*0.3*	*0.01*
Unwanted Motion of Operator	*0.18*	*0.03*	*0.09*	*0.02*	*0.25*
Over Processing	*0.14*	*0.02*	*0.26*	*0.06*	*0.02*
Transportation	*0.1*	*0.43*	*0.03*	*0.3*	*0.08*
Sum	*1*	*1*	*1*	*1*	*1*

Normalized Principal Eigen Vector Matrix

$$W = 1/5 \begin{pmatrix} 2.38 \\ 0.8 \\ 0.57 \\ 0.5 \\ 0.94 \end{pmatrix} = \begin{pmatrix} 0.48 \\ 0.16 \\ 0.11 \\ 0.1 \\ 0.19 \end{pmatrix}$$

$\lambda_{max} = 7.73$
$CI = \lambda_{max} - n / (n-1) = 0.68$
$CR = CI / RI = 0.6 < 10\%$

N	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
RI	*0*	*0*	*0.58*	*0.9*	*1.12*	*1.24*	*1.32*	*1.41*	*1.45*	*1.49*

V. CONCLUSION

In this paper the current inventory cost has been calculated for the past five years and for the next five years inventory costs have been forecasted. Then AHP have been applied to find what are the factors affecting Inventory cost and in the result Over Production is found to be the major contributing factor and it's been reduced to control the Total Inventory Cost.

REFERENCES

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[4] STEFAN MINNER (2006) proposed a different approach to obtain the economic order quantity and several extensions without taking derivatives is presented.