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The Effect of Inventory Management on Organizational Performance

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Abstract: Inventory constitutes the most significant part of majority of Indian manufacturing industries. Because of the huge inventories maintained by most firms, a considerable sum of an organization's fund is being committed to them. Thus it becomes absolutely imperative to manage inventories efficiently so as to avoid the costs of changing production rates, overtime, sub-contracting, unnecessary cost of sales and back order penalties during periods of peak demand. The main objective of this study is to control inventories in the AMTEK AUTO LIMITED, Bhiwadi Plant by using the various existing tools of optimization in inventory management. The study methods employed includes the variance analysis, Economic Order Quantity (EOQ) Model and the Chi-square method. The answer to the fundamental question of how best an organization handles inventory by using various optimization techniques. Consequently, recommendations on the right quantity, quality and timing of material, at the most favorable price conclude the research study.

1.Introduction:

Inventory management is pivotal in effective and efficient organization. It is also vital in the control of materials and goods that have to be held (or stored) for later use in the case of production or later exchange activities in the case of services. The principal goal of inventory management involves having to balance the conflicting economics of not wanting to hold too much stock. Inventory problems of too great or too small quantities on hand can cause business failures. If a manufacturer experiences stock-out of a critical inventory item, production halts could result. Moreover, a shopper expects the retailer to carry the item wanted. If an item is not stocked when the customer thinks it should be, the retailer loses a customer not only on that item but also on many other items in the future. The conclusion one might draw is that effective inventory management can make a significant contribution to company's profit as well as increase its return on total assets. It is thus the management of this economics of stockholding, that is appropriately being refers to as inventory management. The reason for greater attention to inventory management is that this figure, for many firms, is the largest item appearing on the asset side of the balance sheet. Yang et al [1] has argued that supply chains have evolved from traditional forecast-driven push to demand-driven pull systems over time, and that postponement is playing an increasingly important role in a supply chain. Wanke [2] states that inventory management approaches are a "function of product, operational and demand related variables such as delivery time, obsolescence, coefficient of variation of sales and inventory turnover" and that logistics managers are more likely to decentralise inventory in order to stock product close to the customer's facility if the customers demand a reduced delivery time. Graman [3] argued that today, the cost of holding inventory, extensive product proliferation and the risk of obsolescence, especially in rapidly changing markets, make the expense of holding large inventories of finished goods excessive and that high demand items naturally have safety stock assigned to them but in many organisations there are so many very-low-demand items that keeping any stock of these items is unreasonably expensive, so they argue that companies must now provide good service while maintaining minimal inventories. Therefore, inventory management approaches are essential aspects of any organisation.

Basic Economic Order Quantity Model:

The basic EOQ model (short for economic order quantity model) has long been the most widely used inventory model. Its popularity is due to a combination of simplicity and wide applicability. First introduced in 1913 by Ford W. Harris, an engineer with the Westinghouse Corporation, it has continued to be a key tool of inventory management for nearly a century.

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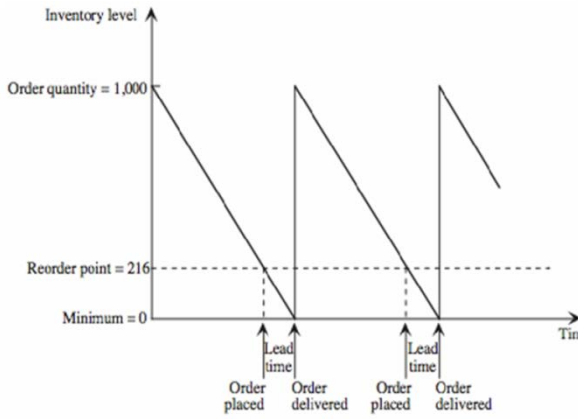

Figure 1: EOQ with constant demand

Chi Square Test: Chi-square statistic: used when analysing categorical data

Notation: $\chi^2 = \sum \frac{(\text{Obs}-\text{Exp})^2}{\text{Exp}}$ = difference of residuals squared

Assumptions & Conditions:

- Counted Data Condition: make sure the data are counts for the categories of a categorical variable.
- Randomization Condition: if you wish to generalize your results to the population, then the individuals who were counted must be a random sample from some population.
- Expected Cell Frequency Condition: you should expect to see at least 5 individuals in each cell.

Hypothesis Testing:

Step one: State null hypothesis and alternative hypothesis in symbolic form. Usually the hypothesis concerns the value of a population parameter. Identify H_1 first. If the original claim of the question uses words such as "greater, larger, increased, improved and so on", use ">" for H_1. If it uses words such as "less, decreased, smaller and so on", apply "<" for H_1. If words such as "the same, change, different/difference and so on" appear in the claim, use "≠" for H_1. The opposite symbol will be used for H_0.

Step two: Compute the test statistics value.

Step three: Identify the critical value or the P-value by the tables.

Table 2 Sales in rupees (Volume of Production)

Be aware of how many tails exist when you look up the critical value in the table. If the symbols ">,<, ≥,≤" are used in H_1, it is one-tailed. If the symbol "≠" is used in H_1, two-tailed. The significance levels 1%, 5% and 10% are commonly used. Confidence Level + Significance Level = 1 i.e. Confidence Level = 1 – Significance Level. Therefore, when significance level equals 1%, 5% or 10%, confidence level equals 99%, 95% or 90% respectively.

2.Data Presentation and Interpretation:

The preceding section dwells on quantitative information of the plant. Here the data are entirely quantitative as collected from the accounts department, manufacturing department and the store. Table 1 show the total sales of the company in rupees value for fourteen years (2000-2013). The company witnessed a surplus for the fourteen years. Understudy, because there was a positive variation in each of the years. Positive variation indicates good performance on the part of the company while negative variation indicates poor performance, since the basic objective of any profit-making company is to maximise sales**.**

Table 1 Sales (in Millions of rupees)

YEARS	BUDGETED SALES	ACTUAL SALES	VARIANCE
2000	30	36.66	6.66
2001	35	39.42	4.42
2002	42	45.68	3.68
2003	45	47.02	2.02
2004	52	62.04	10.04
2005	54	59.76	5.76
2006	63	65.07	2.07
2007	72	80.08	8.08
2008	77	85.94	8.94
2009	80	89.92	9.92
2010	85	86.45	1.45
2011	94	95	1
2012	100	101.25	1.25
2013	110	113.14	3.14

Table 2 Sales in Rupees

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YEARS	BUDGETED SALES	ACTUAL SALES	VARIANCE
1999	2,500,000	2,450,000	-50,000
2000	2,750,000	2,700,000	-50,000
2001	3,045,000	3,000,000	-45,000
2002	3,200,000	3,160,000	-40,000
2003	3,360,000	3,350,000	-10,000
2004	3,540,000	3,500,000	-40,000
2005	3,820,000	3,820,000	0
2006	4,015,000	4,005,000	-10,000
2007	4,200,000	4,190,000	-10,000
2008	4,500,000	4,425,000	-75,000
2009	4,500,000	4,500,000	0
2010	4,750,000	3,950,000	-80,000
2011	4,900,000	4,700,000	-200,000
2012	4,950,000	3,756,621	-1193397
2013	5,150,000	5,100,000	-50,000

Table 3 Production cost (in Millions of rupees)

YEARS	BUDGETED SALES	ACTUAL SALES	VARIANCE
1999	12	12.50	0.5
2000	20	21.76	1.76
2001	27	28.50	1.50
2002	35	36.14	1.14
2003	41	41.50	1.50
2004	52	52.70	0.7
2005	59	60.15	1.15
2006	63	63.25	0.25
2007	65	66.75	1.75
2008	72	73.40	1.40
2009	77	78.25	1.25
2010	82	83.55	1.55
2011	86	87.35	1.35
2012	94	95,25	1.25
2013	98	99	1

3.Data Analysis and Hypothesis Testing:

The data in tables 4, 5, 6 show the usage rate of Amtek Auto Limited Company's raw materials (that is nodular cast iron, Fabricated Cast Iron, water). The data were used to determine the observed frequency value using the economic order quantity (EOQ) formula. The expected frequency was determined by finding the average of all the observed frequency. The $(O-E)^2/E$ value was then determined at 5% confidence level and 14 degree of freedom, see tables 4, 5 and 6.

SAMPLE CALCULATION:

1. CALCULATE THE VALUE OF EOQ FOR THE YEAR 1999

ANNUAL DEMAND (D) =130 Units/year

MATERIAL UNIT COST (m) = RS. 110 /Units

INVENTORY CARRYING COST (n) as % of unit=7%

VALUE OF CARRYING COST (C_C) = m*n=110*7/100=7.70

ORDERING COST (C_O) = RS.6 units/year

EOQ (O) = $\sqrt{2DC_O}/\sqrt{C_C} = \sqrt{2}*130*6/\sqrt{7.7} = 14.2$

SO, SIMILARLY CALCULATE EOQ FOR 2000-13

2. CALCULATE EXPECTED EOQ BY TAKING AVERAGE OF EOQ FOR 1999-2013.EXPECTED VALUE OF EOQ (E) = (14.2+14.2+14.2+20+17.8+16.6+21.1+25.8+27.1+29.3+33.8+42.6+42.7+44.1+50.5)/15 =27.6

3. TAKE OUT THE DIFFERENCE OF OBSERVED EOQ AND EXPECTED EOQ.THEN SQUARE IT.

FOR YEAR 1999, OBSERVED EOQ (O) =14.2, EXPECTED EOQ (E) = 27.6

SQUARE OF CORRECTED DIFFERENCE $(O-E)^2$ = $(14.2-27.6)^2$=181.4

4. AFTER THAT, DIVIDE THE SQUARE OF CORRECTED DIFFERENCE BY EXPECTED EOQ.

$(O-E)^2/E$=181.4/27.6=6.55

5. SIMILARLY THE VALUE FOR REMAINING YEARS HAVE BEEN CALCULATED.

6. THEN ADD ALL THE VALUES.

$\sum (O-E)^2/E$= (6.55+6.49+6.57+2.13+3.52+4.4+1.11+.12+.00009+.18+1.34+8.12+8.16+9.78+18=77.40

7. COMPARE THE RESULT FROM TABLE & ABOVE CALCULATED VALUE.

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TABLE 4 FABRICATED CAST IRON

Years	Annual demand (D)	No of orders	Material unit cost (m)	Ordering cost per order (C_O)	Carrying cost as a % of unit (n)	($C_{C=m*n}$) value	(000) O EOQ Economic order quantity	(000) E Expected Value	(000) $O -E)^2$ square of corrected difference	(000) $(O -E)^2/ E$
1999	130	36	110	6	7%	7.70	14.2	27.6	181.4	6.55
2000	140	36	120	7	8%	9.60	14.2	27.6	179.8	6.49
2001	150	36	130	7	8%	10.4	14.2	27.6	181.9	6.57
2002	160	36	140	7	4%	5.60	20.0	27.6	59.1	2.13
2003	170	36	150	7	5%	7.50	17.8	27.6	97.6	3.52
2004	190	36	160	7	6%	9.6	16.6	27.6	122.1	4.40
2005	250	36	170	5	3%	5.10	21.1	27.6	30.81	1.11
2006	300	36	180	8	4%	7.20	25.8	27.6	3.53	0.12
2007	350	36	190	8	4%	7.60	27.1	27.6	.0025	.00009
2008	430	36	200	8	4%	8.00	29.3	27.6	4.97	.18
2009	450	36	210	8	3%	6.30	33.8	27.6	37.33	1.34
2010	600	36	220	10	3%	6.60	42.6	27.6	225	8.12
2011	700	36	230	12	4%	9.20	42.7	27.6	226.2	8.16
2012	720	36	240	13	4%	9.60	44.1	27.6	270.9	9.78
2013	800	36	250	124	5%	12.5	50.5	27.6	524.4	18.93

$\sum (O-E)^2/E = 77.40$

Table 5 NODULAR CAST IRON

YEARS	Annual demand (D)	No of orders	Material unit cost (m)	Ordering cost per order (C_O)	Carrying cost as a % of unit (n)	($C_{C=m*n}$) Value	EOQ (000) O Economy Order Quantity	(000) *E* Expected Value	(000) $(O -E)^2$ Square of corrected difference	(000) $(O -E)^2/ E$
1999	390	36	95	3	7%	6.65	18.75	26.45	59.29	2.24
2000	420	36	105	3	8%	8.40	17.32	26.45	83.35	3.15
2001	450	36	120	3	7%	8.40	17.9	26.45	73.10	2.7
2002	520	36	125	4	7%	8.75	21.8	26.45	21.62	0.81
2003	570	36	140	4	7%	9.80	28.5	26.45	4.20	0.15

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2004	610	36	150	5	7%	10.50	28.5	26.45	4.20	0.15
2005	660	36	180	6	6%	10.80	27.08	26.45	0.39	0.01
2006	690	36	220	6	4%	8.80	30.6	26.45	17.22	0.65
2007	740	36	250	6	4%	10	29.7	26.45	10.56	0.39
2008	810	36	280	6	4%	11.2	29.45	26.45	9	0.34
2009	840	36	320	7	4%	12.8	30.31	26.45	14.89	0.56
2010	900	36	360	8	4%	14.4	31.6	26.45	26.52	1
2011	950	36	410	9	5%	20.5	28.88	26.45	5.90	0.22
2012	1010	36	480	11	6%	28.8	27.77	26.45	1.74	0.06
2013	1070	36	520	12	6%	31.20	28.6	26.45	4.62	0.17

$\sum (O-E)^2 / E = 12.6$

Table 6 WATER

Years	Annual demand (D)	No of orders	Material unit cost (m)	Ordering cost per hour ($C_{O)}$	Carrying cost as a % of unit (n)	($C_{C=m*n}$) Value	EOQ (000) O Economy Order Quantity	(000) E Expected Value	(000) *(O -E)2* Square of corrected difference	(000) $(O-E)^2/E$
1999	170	36	80	7	3%	2.40	31.49	37.58	37.08	0.98
2000	180	36	90	7	3%	2.7	30.55	37.58	49.42	1.31
2001	200	36	100	7	3%	3	30.55	37.58	49.42	1.31
2002	220	36	110	6	3%	3.3	28.28	37.58	86.49	2.3
2003	280	36	120	6	3%	3.6	30.55	37.58	49.42	1.31
2004	310	36	130	6	3%	3.9	30.88	37.58	44.89	1.94
2005	370	36	140	8	3%	4.2	37.54	37.58	0.016	.00004
2006	400	36	150	9	3%	4.5	37.71	37.58	0.0169	.00004
2007	490	36	160	9	3%	4.8	42.86	37.58	27.87	0.741
2008	550	36	200	9	3%	6	40.62	37.58	9.24	0.24

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2009	650	36	240	9	3%	7.2	38.01	37.58	0.184	0.004
2010	840	36	300	10	3%	9	43.20	37.58	31.58	0.840
2011	900	36	330	11	3%	9.9	44.72	37.58	50.97	1.356
2012	950	36	350	13	3%	10.5	48.50	37.58	119.24	3.17
2013	1000	36	400	14	3%	12	48.30	37.58	114.91	3.5

$\sum (O-E)^2/E = 19.01$

Company does not make use of Economic order quantity [EOQ] optimization model to evaluate their inventory using nodular cast iron as parameter for measurement. Using water as parameter, table 6 depicts the $\sum (O-E)^2/E$ calculated value of 19.01, which of course is lower when compared with table value of chi-square $\sum (O-E)^2/E$ of 23.7. The null hypothesis was thus accepted Amtek Auto Limited. Company does not make use of Economic order quantity [EOQ] optimization model to evaluate their inventory using water as parameter for measurement.

4.Conclusion: Inventory constitutes the most significant part of current assets of larger majority of Indian manufacturing industries. Because of the relative largeness of inventories maintained by most firms, a considerable sum of an organization's fund is being committed to them. It thus becomes absolutely imperative to manage inventories efficiently so as to avoid the costs of changing production rates, overtime, sub-contracting, unnecessary cost of sales and back order penalties during periods of peak demand. The main objective of this study is to determine whether or not inventories in the AMTEK AUTO LIMITED, BHIWADI Plant can reduce to optimum level. Consequently, recommendations on the right quantity, quality and timing of material, at the most favorable price conclude the research study. AMTEK AUTO LIMITED does not making use of EOQ. That's why they are keeping more inventory. Before implementing the EOQ method inventory of ring gear was 4 crore in warehouse of AMTEK AUTO LIMITED, BHIWADI Plant. And if we implement the EOQ method, inventory of ring gear may reduce to 2.75 crore reducing the inventory cost by 43.75% in warehouse of AMTEK AUTO LIMITED, BHIWADI Plant. This can be possible when company modified its policy of keeping inventory of 21 days to 14 days. In present industrial scenario INVENTORY MANAGEMENT procedures are commonly implemented by manual procedures. Due to complexity of available published work these procedures are adopted on past experiences. The major role of this study is to look at these problems and introducing the standard approach accordingly to minimize cost at each member involved in supply chain management and gets reducing the cost.

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