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Simulation of Inventory System- A case study

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ABSTRACT : *Inventory management is an important aspect of material management and decision sciences. A huge investment has been made by firms to manage the inventory properly so that the optimal ordering policies can be developed which will help the firms to achieve the objective of cost minimization. The productivity of a firm is greatly influenced can be tremendously improved by improving the service levels and also by careful study of present inventory policies, the future inventory ordering policies can be developed. Inventory levels have to be monitored so that the stock of item can be maintained. In the present paper, the inventory details from a cold storage plant were collected. Selective inventory control technique ABC analysis is used to classify the items which need close monitoring. Statistical analysis of A class items has been performed as they have the maximum consumption value*

Keywords: *About ABC analysis; service level; Chi Square test; Simulation; demand*

I. INTRODUCTION

Inventory control holds huge importance to the firm. It has become important for the industries to keep low inventory levels these days and high service levels from vendor is demanded as it would reduce the carrying costs for the industry though the shortages must be taken into consideration. The firms also consider the market conditions while ordering an item like the price discount or availability of items play a huge role. The ABC analysis helps to effectively monitor a few items which contribute more to the total costs. The Chi Square Test is a statistical hypothesis test for the sampling distribution of the test statistic when the null hypothesis is true. Chi-squared tests are often constructed from a sum of squared errors, or through the sample variance. Simulation is the imitation of a real world problem using a particular model under the given set of conditions. Simulation is performed in cases where performing mathematical analysis isn't possible.

II. LITERATURE REVIEW

The present paper is based on developing an ordering policy for the items stored in the inventory based on the annual consumption of the items which will help the firm to focus on the few handful of items instead of whole inventory. With proper monitoring of these items, losses can be greatly reduced. Statistical analysis is also performed for the A class items to determine if the demand is consistent.

Geetha Mani, et al. [2] combined the ABC analysis and VED analysis to classify the products based on cost and criticality.ABC analysis has also been an area of research for authors like Pramod Kumar et al. [1]. Gulsen Aydin Keskin[3] tried to overcome the limitation of ABC analysis by applying multiple criteria for the ABC analysis. Jennifer L Waller et al. [4], M Leigh Lunsford et al. [8] and Dong Fugui a et al. [5] conducted Chi Square test for various calculations to detertime its suitability. Eugene Kopytov et al. [6], Neetu [7] and Gionna Boero et al. [9] studied the uses of simulation in inventory system. In this paper we have combined the results of ABC analysis with the Chi Square test and simulation of A class items, thus optimal ordering policicies and reorder level can be adjusted according to the demand, thus the problem of over stocking and stock outs can be prevented.

III. METHODOLOGY

3.1. Objectives of the Project

The objectives of the project are:

1. Study of present inventory ordering policy of the industry.
2. Performing the ABC analysis to classify items based on annual consumption.
3. Performing Chi Square test for the statistical analysis of A class items to determin if demand is consistent.
4. Simulation of demand if the demand is inconsistent

3.2 Procedure Followed In the Paper

Step 1: The relevant data recording present system has been analyzed.

Step 2: Based on the selective control methods items are classified as A, B and C class items as per their cost contribution.

Step 3: Chi Square test is performed to determine if the demand pattern follows mathematical model.

Step 4: Simulation of demand values when the demand doesn't follow a mathematical pattern.

3.3 Inventory Details

To arrive at the objectives of the given project, the present inventory control system is analyzed. Data related to inventories maintained are collected and the ABC analysis is performed based on the consumption value. The details are given in the table1

Table1 Inventory details related to annual demand and price per unit & ABC analysis based on consumption value

Item code	Item description	Price/unit	Annual demand	Consumption Value	% consumption	Class
ECS01	Valves Grade1	2400	1620	3864660	10.35	A
ECS02	Bearings Grade1	970	190	198800	0.54	C
ECS03	Pipes Class	16000/12ft	260	4341480	11.7	A
ECS04	Steel	7000/kg	230	1549880	4.175	B
ECS05	Cement	6/kg	237420	1424620	3.84	B
ECS06	Bricks	1.5	917480	1457250	3.93	B
ECS07	Gitty	6/cubic ft	141000	904000	2.44	B
ECS08	Angle	390	7790	3059080	8.24	A
ECS09	Sand	28/cubic ft	24420	683600	1.84	B
ECS10	Bulbs	75	2670	200200	0.54	C
ECS11	Motor	1700	240	429580	1.16	C
ECS12	Carbon Slipring	30	3940	125000	0.34	C
ECS13	Water	6/L	1200000	7137900	19.23	A
ECS14	Oil Filter	50	320	15700	0.036	C
ECS15	Diesel Filter	170	70	9320	0.025	C
ECS16	Oil Grade1	2800/L	920	2580700	7	A
ECS17	Welding Rod	600	380	220000	0.6	C
ECS18	Red Oxide	186/L	2820	523000	1.41	B
ECS19	Paints	240/L	2800	669850	1.8	B
ECS20	Nuts & Bolts	20	9240	184850	0.5	C
ECS21	Welding Cable	120/m	2100	249800	0.67	C
ECS22	Belt	374	705	260500	0.7	C
ECS23	Salt	150/kg	7920	1188840	3.2	B
ECS24	Ammonia Gas	48/L	51180	2456680	6.62	A
ECS25	Valves Grade 2	2100	510	1257300	3.39	B
ECS26	Bearings Grade2	880	200	227500	0.61	C
ECS27	Pipes	1600	260	417520	1.12	B
ECS28	Agitators	300	990	292600	0.8	C
ECS29	Cartridge	575	190	90000	0.24	C
ECS30	Papers	250/set	440	117000	0.32	C
ECS31	UPS	1500	200	286400	0.77	C
ECS32	Oil Grade2	2000	150	389700	1.05	B
ECS33	Filter	560	200	108630	0.29	B
ECS34	Diesel	50	8420	421050	1.134	C

3.4 Statistical analysis of A class items

Chi Square test is performed to determine if the demand pattern is consistent. For performing the Chi Square test, the observed values and expected values are taken and the parameter $(O-E)^2/E$ is calculated. The sum of these values for all observations is measured against the critical value obtained from the Chi Square table to test if it follows null hypothesis,

Table 2 Chi Square test for valve g1

Observed	Expected	$(O-E)^2/E$
90	264	114.68
240	264	2.18
220	264	7.33
220	264	7.33
200	264	15.52
150	264	49.23
320	264	11.88
300	264	4.91
320	264	11.88
280	264	0.97
190	264	20.74
360	264	34.91
360	264	34.91
360	264	34.91
350	264	28.02

 $(O-E)^2/E= 379.39$
No of columns=15, Degree of freedom=15-1=14, Critical value=31.319

Since the critical value is smaller than $(O-E)^2/E$, the null hypothesis doesn't hold true.
Similarly, the Chi Square test can be performed for all other A class items.

3.5 Simulation of demand for A class items

The simulation model is proposed for the case when the demand is inconsistent. Microsoft Excel is used for generating random numbers and then the corresponding demand was written in the column next to it for the A class items. Thus, the various simulation models were made. For each item, first the class intervals, frequency, cumulative frequency and the intervals for the random numbers were written in the columns and the random numbers were generated using the command =RAND()*100 as the requirement for the random numbers was between 0-99.

Table 3 Random no allocation for Pipes Class

Value	Frequency	Probability	Cumulative Probability	Random no Interval
0	9	0.25	0.25	0-24
10	8	0.222	0.47	25-46
20	8	0.222	0.69	47-68
30	4	0.111	0.81	69-80
40	3	0.083	0.89	81-88
50	4	0.111	1.00	89-99

The simulation spreadsheet was then drawn.

Table 4 Simulation Spreadsheet

Week	Random no	demand	Weekly demand	initial stock	end stock	units ordered	lead time units received	units received
1	55	20	4.67	65	60.33			
2	2	0	0.00	60.33	60.33			
3	80	30	7.00	60.33	53.33	28.5	3	
4	5	0	0.00	53.33	53.33			
5	6	0	0.00	53.33	53.33			
6	65	20	4.67	81.83	77.17			28.5
7	81	40	9.33	77.17	67.84			
8	42	10	2.33	67.84	65.50			
9	30	10	2.33	65.50	63.17			
10	38	10	2.33	63.17	60.84			
11	43	10	2.33	60.84	58.50			
12	43	10	2.33	58.50	56.17			
13	3	0	0.00	56.17	56.17	28.5	3	
14	87	40	9.33	56.17	46.84			

15	34	10	2.33	46.84	44.50			
16	77	30	7.00	73.00	66.00			28.5
17	27	10	2.33	66.00	63.67			
18	10	0	0.00	63.67	63.67			
19	66	20	4.67	63.67	59.00			
20	48	20	4.67	59.00	54.34			
21	9	0	0.00	54.34	54.34	28.5	3	
22	19	0	0.00	54.34	54.34			
23	23	0	0.00	54.34	54.34			
24	94	50	11.67	82.84	71.17			28.5
25	79	30	7.00	71.17	64.17			
26	53	20	4.67	64.17	59.51			
27	77	30	7.00	59.51	52.51			
28	44	10	2.33	52.51	50.17	28.5	3	
29	26	10	2.33	50.17	47.84			
30	36	10	2.33	47.84	45.51			
31	99	50	11.67	74.01	62.34			28.5
32	24	0	0.00	62.34	62.34			
33	95	50	11.67	62.34	50.68			
34	19	0	0.00	50.68	50.68	28.5	3	
35	4	0	0.00	50.68	50.68			
36	20	0	0.00	50.68	50.68			
37	67	20	4.67	79.18	74.51			28.5
38	25	10	2.33	74.51	72.18			
39	98	50	11.67	72.18	60.51			
40	16	0	0.00	60.51	60.51			
41	75	30	7.00	60.51	53.51			
42	33	10	2.33	53.51	51.18	28.5	3	
43	2	0	0.00	51.18	51.18			
44	64	20	4.67	51.18	46.51			
45	61	20	4.67	75.01	70.34			28.5
46	70	30	7.00	70.34	63.34			
47	48	20	4.67	63.34	58.68			
48	91	50	11.67	58.68	47.01			
49	93	50	11.67	47.01	35.35	28.5	3	
50	29	10	2.33	35.35	33.01			
51	7	0	0.00	33.01	33.01			
52	38	10	2.33	61.51	59.18			28.5

Similarly, the simulation of other A class items can be performed.

IV. RESULTS & DISCUSSION

By applying the ABC analysis, the 34 items in the inventory were categorized on the basis of consumption value.6 items belong to the A class which are Valve g1, Pipes Class, Angle, Water, Oil g1 and Ammonia gas. Chi Square test has been performed for the statistical analysis of A class items to determine if they follow null hypothesis and simulation has been carried out if they don't follow null hypothesis and future demand for the next 100 months is found out. The simulation for Pipes Class was done for 52 weeks and during that period, no shortages occurred and 7 orders were placed. This study can be further extended by using other selective control techniques. Also it can be extended to large scale industries where the number of items to be procured are more.

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