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Design of Inventory System- A case study

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ABSTRACT : *In the business environment of today's world, with the ever increasing demand to increase profitability and reduce overall costs, inventory management has become a key part of material management. Firms have made an effort, especially in the last two decades to optimize the production level by efficient management of the inventory. It is because of the reason that the productivity of a firm is greatly influenced by the inventory policies. In the present paper, the inventory details from a cold storage plant were observed. By applying some inventory management techniques like the selective control ABC analysis and the inventory control system, optimal ordering policies can be developed which will help the industry to provide finished product at the right time. The results were then compared with the use of software*

Keywords: *Selective inventory control techniques; lead time; inventory control system; reorder level; Q system.*

I. INTRODUCTION

All the firms have placed firm focus on reduction of waste and overall cost. The two goals of inventory control are reduction of costs incurred and the provision of maximum service level are in accordance with the firm's objective to reduce waste. Inventories include the raw materials, semi finished products, finished goods as well as the spare parts inventory. The ABC analysis helps to effectively control limited items which contribute more to the total costs. The inventory control system is described for the situations of lead time fluctuation or demand fluctuation. The two types of replenishment systems being fixed period system (P system) and fixed quantity system (Q system) are suggested based on the ABC classification of items.

II. LITERATURE REVIEW

The present paper is based on developing a reorder level for the items stored in the inventory and suggesting proper ordering policies to the firm on basis of the annual consumption 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.

Gulsen Aydin Keskin et al. [6] and T.V.S.R.K Prasad et al. [2] used multi criteria ABC analysis to overcome the limitations of ABC analysis as the ABC analysis only classifies items based on the consumption. Maj Sushil Kumar et al. [1] and Dr Poorwa Wandalkar et al. [4] combined the ABC and VED analysis to do the same by forming a matrix of ABC-VED. Handanhal Ravinder et al. [3] and Dinesh Dhoka et al . [5] also applied ABC analysis for optimizing the inventory service levels. Sunil Chopra et al . [9] studied the relation between the lead time and the safety stocks. Henk Tijms et al. [11], Fangruo Chen [10] and Ronald D Fricker Jr et al. [8] used different approaches to determine the reorder level under different conditions. K Balaji et al. [7] studied the effects of slow moving items in the inventory where the work of various authors were studied to determine optimal ordering policy.

In this paper the results of ABC analysis with inventory control system are combined combined as Q system is suggested for A class items and P system for B & C class items.

III. METHODOLOGY

3.1. OBJECTIVES OF THE PROJECT

The objectives of the project are:

1. Study of present methods of inventory management of the industries.
2. Performing the ABC analysis to classify items based on annual consumption.
3. Suggesting the mode of replenishment of the item based on comparative consumption.
4. Computation of reorder point of the item.

Comparison of results with the use of software

3.2 PROCEDURE FOLLOWED IN THE PAPER

Step 1: The relevant data recording present system has been collected and analyzed**.**
Step 2: Based on the selective control methods items are classified as A, B and C class items as per their consumption values.
Step 3: Q system is selected as mode of replenishment for A class items and P system is selected as mode of replenishment for B & C class items.
Step 4: Reorder level is calculated for all items**.**
Step 5: POM QM for windows version 4 is used to compare the results**.**

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 Computation of Reorder level

The reorder level is the stock for the lead time period. It is the sum of buffer stock, reserve stock and safety stock. Q system is applied for A class items and P system is applied for B & C class items.

3.4.1 Q system

For the q system, the value of buffer stock, reserve stock and safety stock are given by the expression
Buffer Stock= Lead Time (in weeks) × weekly demand
Reserve stock = z × std deviation, for q system we assume z= 1.64 for 95% service level
Safety stock= (Maximum demand- Average demand)

Table 2 Computation of Buffer Stock for Q system

Item Description	Lead Time(in weeks)	Annual Demand	Weekly Demand	Buffer Stock
Valves Grade1	3	1620	31.154	93.462
Pipes Class	3	260	5.000	15.000
Angle	3	7790	149.808	449.423
Water	3	1200000	23076.923	69230.769
Oil Grade1	3	920	17.692	53.077
Ammonia Gas	3	51180	984.231	2952.692

Table 3 Computation of Safety stock for Q system

Item Description	Lead Time(in weeks)	Maximum Demand	Average Demand	(Max-Avg) Demand	Safety stock
Valves Grade1	3	84	31.154	52.846	158.538
Pipes Class	3	11.67	5.000	6.670	20.010
Angle	3	200.65	149.808	50.842	152.527
Water	3	48996	23076.923	25919.077	77757.231
Oil Grade1	3	37.33	17.692	19.638	58.913
Ammonia	3	2060.2	984.231	1075.969	3227.908

For Reserve stock calculation for Valve g1,we have
Here $\sum (x- \mu)^2 = 488155.6$
$\sum (x- \mu)^2 \div n = 13559.88$
Therefore the standard deviation = $\sqrt{0.75 \times 13559.88} = 100.85$
The reserve stock = z × std deviation
= 1.64 × 100.85
=165.39
Where x= present demand,μ= avg demand

Similarly, the reserve stock for other items can be computed to determine the reorder level.

Table 4 Reorder level for Q system

Item Description	Buffer Stock	Reserve Stock	Safety Stock	Reorder Level
Valve g1	93.462	165.39	158.54	417.392
Pipes Class	15	23.14	20.01	58.150
Angle	449.423	262.58	152.53	864.533
Water	69230.77	59536.44	77757.23	206524.440
Oil g1	53.077	73.9	58.91	185.887
Ammonia Gas	2952.652	4862.09	3327.91	11142.652

3.4.2 P system

For the p system, the expression for the buffer stock and the safety stock changes as the cycle time is added to the lead time. The cycle time is given by
Cycle time = EOQ/demand rate
The expression for buffer stock, safety stock and reserve stock in p system are:
Buffer stock = weekly demand × (lead time + cycle time)
Safety stock = (maximum-average demand) × (lead time + cycle time)
For p system, z= 1.28, for service level 90%

Reserve stock= z × std deviation

Table 5 Buffer stock calculation for P system

Item Description	Lead time(in weeks)	Weekly demand	Q	Cycle time(in weeks)	Lead time+ cycle time	Buffer stock
Bearings Grade 1	5	3.654	24.24	6.63	11.63	42.509
Steel	5	4.423	26.89	6.08	11.08	49.005
Cement	5	4565.769	2813.18	0.62	5.62	25642.026
Bricks	5	17643.846	5530.16	0.31	5.31	93749.391
Gitty	5	2711.538	6855.65	2.53	7.53	20413.342
Sand	5	469.615	132.07	0.28	5.28	2480.147
Bulbs	5	51.346	188.68	3.67	8.67	445.411
Motor	5	4.615	31.44	6.81	11.81	54.517
Carbon Slipring	5	75.769	256.26	3.38	8.38	635.106
Oil Filter	5	6.154	56.57	9.19	14.19	87.339
Diesel Filter	5	1.346	24.85	18.46	23.46	31.581
Welding Rod	5	7.308	56.27	7.70	12.70	92.808
Red Oxide	5	54.231	123.13	2.27	7.27	394.284
Paints	5	53.846	108.01	2.01	7.01	377.241
Nuts & Bolts	5	177.692	480.62	2.70	7.70	1369.082
Welding Cable	5	40.385	132.29	3.28	8.28	334.213
Belt	5	13.558	53.17	3.92	8.92	120.958
Salt	5	152.308	162.48	1.07	6.07	924.018
Valves Grade 2	5	9.808	41.23	4.20	9.20	90.268
Bearings Grade2	5	3.846	32.11	8.35	13.35	51.341
Pipes	5	5.000	28.50	5.70	10.70	53.500
Agitators	5	19.038	99.50	5.23	10.23	194.692
Cartridge	5	3.654	34.89	9.55	14.55	53.159
Papers	5	8.462	59.33	7.01	12.01	101.638
UPS	5	3.846	30.55	7.94	12.94	49.781
Oil Grade2	5	2.885	21.21	7.35	12.35	35.633
Filter	5	3.846	32.73	8.51	13.51	51.961
Diesel	5	161.923	410.37	2.53	7.53	1219.985

Table 6 Safety stock calculation for P system

Item Description	Lead time(in weeks)	Max demand	Avg demand	q	Cycle time(in weeks)	Safety stock
Bearings Grade 1	5	11.67	3.654	24.24	6.63	93.261
Steel	5	11.67	4.423	26.89	6.08	80.292
Cement	5	9449.37	4565.769	2813.18	0.62	27427.014
Bricks	5	40377.97	17643.846	5530.16	0.31	120796.24
Gitty	5	6066	2711.538	6855.65	2.53	25253.476
Sand	5	875	469.615	132.07	0.28	2140.929
Bulbs	5	95.66	51.346	188.68	3.67	384.408
Motor	5	7	4.615	31.44	6.81	28.167
Carbon Slipring	5	140	75.769	256.26	3.38	538.389
Oil Filter	5	25.66	6.154	56.57	9.19	276.844
Diesel Filter	5	7	1.346	24.85	18.46	132.639
Welding Rod	5	11.67	7.308	56.27	7.70	55.402
Red Oxide	5	91	54.231	123.13	2.27	267.330
Paints	5	95.66	53.846	108.01	2.01	292.944
Nuts & Bolts	5	401.31	177.692	480.62	2.70	1722.927
Welding Cable	5	95.66	40.385	132.29	3.28	457.445
Belt	5	35	13.558	53.17	3.92	191.303
Salt	5	270.65	152.308	162.48	1.07	717.958

Valves Grade 2	5	56	9.808	41.23	4.20	425.147
Bearings Grade2	5	9.33	3.846	32.11	8.35	73.202
Pipes	5	18.66	5.000	28.50	5.70	146.162
Agitators	5	28	19.038	99.50	5.23	91.643
Cartridge	5	7	3.654	34.89	9.55	48.683
Papers	5	16.33	8.462	59.33	7.01	94.514
UPS	5	11.67	3.846	30.55	7.94	101.264
Oil Grade2	5	7	2.885	21.21	7.35	50.837
Filter	5	9.33	3.846	32.73	8.51	74.086
Diesel	5	200.65	161.923	410.37	2.53	291.782

The reserve stock can be calculated via the same procedure as the Q system**.**

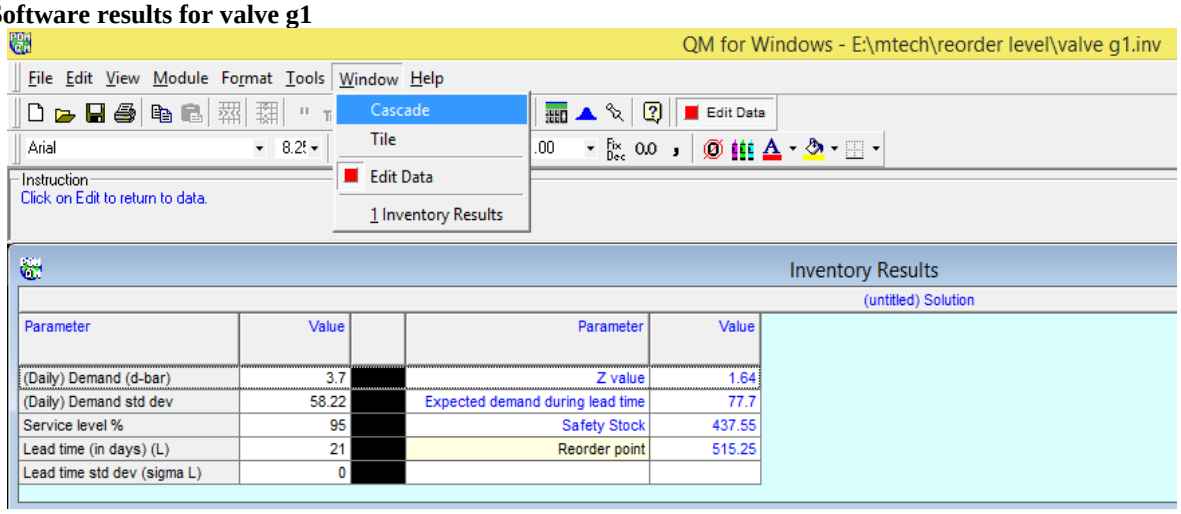
Table 7 Reorder level calculation for P system

Item Description	Buffer Stock	Reserve Stock	Safety Stock	Reorder Level
Bearing Grade 1	42.509	14.74	93.261	150.510
Steel	49.005	16.05	80.292	145.348
Cement	25642.026	11699.5	27427.014	64768.541
Bricks	93749.391	76168.11	120796.239	290713.740
Gitty	20413.342	7796.89	25253.476	53463.708
Sand	2480.147	1096.62	2140.929	5717.696
Bulbs	445.411	167.19	384.408	997.009
Motor	54.517	14.18	28.167	96.864
Carbon Slipring	635.106	226.94	538.389	1400.436
Oil Filter	87.339	32.29	276.844	396.473
Diesel Filter	31.581	8.46	132.639	172.680
Welding Rod	92.808	16.99	55.402	165.200
Red Oxide	394.284	103.64	267.330	765.254
Paints	377.241	134.05	292.944	804.234
Nuts & Bolts	1369.082	558.1	1722.927	3650.108
Welding Cable	334.213	151.71	457.445	943.368
Belt	120.958	49.33	191.303	361.592
Salt	924.018	550.5	717.958	2192.476
Valves Grade 2	90.268	55.67	425.147	571.085
Bearings Grade2	51.341	16.21	73.202	140.752
Pipes	53.500	23.6	146.162	223.262
Agitators	194.692	43.7	91.643	330.035
Cartridge	53.159	12.19	48.683	114.032
Papers	101.638	22.47	94.514	218.622
UPS	49.781	18.69	101.264	169.735
Oil Grade2	35.633	10.5	50.837	96.970
Filter	51.961	13.1	74.086	139.146
Diesel	1219.985	169.29	291.782	1681.058

3.3 Software results

To validate the results of the reorder level obtained by the calculation of p system and q system, POM QM for windows version 4 was used. The input values are the the daily demand, standard deviation for the day, service level and the lead time. The screenshots of various items displaying the reorder level are as follows:

Software results for valve g1



Similarly, software results can be obtained for other items**.**

Table 8 Comparison of Reorder level obtained by calculation & software

Item Description	Reorder Level by software	Reorder Level by calculation	Difference
Valve g1	515.25	417.392	97.858
bearing g1	112.24	150.51	38.27
Pipes Class	74.41	58.15	16.26
Steel	121.17	145.348	24.178
Cement	65912.93	64768.541	1144.389
Bricks	347914.9	290713.740	57201.16
Gitty	50538.3	53463.708	2925.408
Angle	1089.53	864.53	225
Sand	5961.32	5717.70	243.62
Bulbs	1133.47	997.01	136.46
Motor	114.06	96.86	17.2
Carbon slipring	1499.33	1400.44	98.89
Water	213090.7	2062524.44	1849433.74
Oil filter	266.02	396.47	130.45
Diesel filter	88.44	172.68	84.24
Oil g1	234.56	185.89	48.67
Welding rod	166	165.200	0.8
Red oxide	723.57	765.254	41.684
Paint	851.28	804.234	47.046
Nut& bolt	3622.82	3650.108	27.288
W/cable	912.87	943.368	30.498
Belt	307.75	361.592	53.842
Salt	2290.8	2192.476	98.324
Ammonia	15570.46	11142.65	4427.81
Valve g2	315.27	571.09	255.82
Bearing g2	153.07	140.752	12.318
Pipes	149.89	223.262	73.372
Agitators	360.63	330.035	30.595
Cartridge	108.73	114.032	5.302
Paper	176.91	218.622	41.712
UPS	137.14	169.735	32.595
Oil	81.49	96.970	15.48
Filter	101	139.146	38.146
Diesel	1746.16	1681.058	65.102

IV. RESULTS & DISCUSSION

By applying the ABC analysis, the 34 items in the inventory were classified on the basis of consumption value.6 items belong to the A class, 11 items belong to the B class and 17 items are the C class items having least consumption value. The reorder levels of all items obtained from calculation as well as software are in close range, indicating that the ordering policy will be profitable for the firm. The study can be further extended by applying other selective control techniques and also by performing some statistical analysis of A class items.

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