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PREPARATION & APPLICATION OF INVENTORY CONTROL MODEL FOR PAPER INDUSTRY

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ABSTRACT: Inventory is a necessary evil. On the one hand it is required for the smooth production run and on the other hand it is also known as "Cancer of Industry", "Graveyard of Business", "Corporate Obesity" and "a national problem". Inventory Control is today the major profit center.This paper aims at the application of deterministic inventory control models in a paper industry for Raw Materials & Boiler Fuels where the raw material is processed continuously through various systems. Though a number of policies are available in literature to handle inventory control situations but in paper industry, which is a big, complex and a material intensive industry, where it is difficult to control the inventory by any of the existing policies, a combination of some of the available techniques in addition to innovative control policy has been applied. The objective of the paper has been to select an appropriate policy, formulate a model and to determine its optimal solution mathematically. It was felt in the beginning of the study that improved policies could be developed only through a better understanding of the working of the existing supply and inventory management system.

I. INTRODUCTION

Inventory means the array of finished goods which is used in production held by the company The inventory includes stock of raw materials, finished and/or semi – finished products and spare parts etc. In an industrial system, various materials of right quality in right quantity are required at the right place and the right time economically, which needs planning using scientific material management. [1]

1.1 NEED OF INVENTORY MANAGEMENT IN PAPER INDUSTRY

In the globalized world of today where the input costs are increasing day by day, to keep the product competitive in the market and earn reasonable profit, the management in any processing organization has limited options. The main emphasis in such a situation is on cost reduction. Various types of cost expenditures associated with materials are material cost, carrying cost, ordering cost etc. Through some measures, if we are able to reduce a fraction of these costs, a lot of saving occurs. Thus, a good inventory management always aims at reducing various costs tied up with materials. [2] Paper process industry is a big, complex and material intensive industry suffering from a high level of inertia and only embracing change when forced with an external threat such as government regulations or the green movement. [5]
Paper industry is a material intensive industry where different types of materials in large quantity are used. According to "American Forest and Paper Association (AFPA)", the material accounts for more than 50% of the total cost of production. [6] Therefore serious attention has to be paid to this aspect of business management. Thus, the industry input (Raw Materials and Chemicals) and the output (Paper as finished good) requires special attention. In order to ensure continuous operation of each system and continuous production of paper it is necessary to supply raw material without any break at any stage. In the same way, the management of output is also very important in order to avoid accumulation of paper in line. Apart from raw material and finished products, the spare parts and various maintenance supplies also play very important role to keep the equipment in order. These are kept to face any untimely breakdown or malfunctioning of equipment. Although lack of maintenance and other auxiliary functions may not cause the machine to stop, yet their efficiency will certainly be affected. This will directly affect the quality of the product and productivity of the system. Therefore, management should always ensure availability of good quality spare parts and maintenance supplies to achieve efficient production, good quality and profitability with optimum cost. Thus, a scientific inventory management is an essential requirement for a paper industry.

1.2 PAPER INDUSTRY IN INDIA

The Indian paper industry is century old. In 2003,there were 380 paper mills with an installed capacity of nearly 6.2 million tons of paper & paperboard and about 1.1 million tons of newspaper print. It is ranked 15th among the world paper industry. Nearly 65% of the production is based on non-conventional raw materials like agro residues and recycled fiber. The rest 35% is produced from good quality forest based raw materials. The per capita consumption of paper in India stands at 5.5 kg against the world average of 50 kg.

II. RESULTS, ANALYSIS AND DISCUSSIONS

It deals with the analysis of the prevalent inventory system of the organization, presents results, carries out analysis of the da`ta and brings out discussions about the results.
The items required to be kept in Safety Stock are divided in following groups:
a) Raw Materials and Boiler Fuels.

2.1 RESULTS

The inventory model has been applied and the related values re taken from the Paper Plant.
For A Class items (Raw materials and Boiler Fuels), which

are 12 in number, an ordering cost of Rs 200/ order is used. All the 24 Chemicals have been considered as A Class items and their ordering cost is also taken as Rs 200/ order. In addition 44 MRO items have also been identified as A Class items. On the basis of past data and discussion with the top management, the permissible risk of run out is taken as r = 3 years, 5 years and 10 years. The analysis for both Stock Replenishment and Uniform Replenishment has been done and results have already been tabulated in tables.

Existing Inventory Parameters for A Class Items

Sr. No.	Name of the Item	Annual Demand	Cost / Item	Daily Cons.	Rep. Rate	Avg. Cons.	Min. Cons.	Total Cost	Existing Quantity ordered	Existing Safety Stock	Existing Recorder Level	Existing Inventory Holding Cost	Existing Ordering Cost	Average Inventory Cost
		S' (Tons)	Cu (Rs/ton)	Adl (Tons)	Rr	in LT (dd)	in LT (Clmin)	(Lakhs)	(Tons)	B (Tons)	P (Tons)	H = Q+B/2 x Cu x I (Lakhs)	(Lakhs)	(Lakhs)
1	Wheat Straw	41975	2300	115	115	110	100	965.425	1200	460	575	4.772	0.07	19.09
2	Rice Husk	50000	1800	136.98	150	140	136	900	1400	650	800	4.612	0.072	18.45
3	Veneer waste Chips	400	110000	1.09	80	70	59.95	440	80	8.5	75	12.163	0.01	48.675
4	Saikanda	1200	18000	3.28	25	15	12	216	25	13	60	0.855	0.096	3.42
5	Jute Caddy	4500	4500	12.3	13	10	8.7	202	125	80	95	2.328	0.072	4.6125
6	C.P.O.	100	18000	2.7	165	155	135	180	165	13.5	100	8.122	0.002	16.065
7	Imported Wood pulp	13800	1041	37.8	55	50	47.25	143.658	300	150	200	0.585	0.092	2.34225
8	Saw Dust	6000	1300	16.5	20	15	6.8	78	240	50	55	0.471	0.05	1.885
9	Polyester Staple Fibre	300	20000	0.821	55	40	34.48	60	55	3.5	35	1.462	0.01	5.85
10	Baggase	300	20000	0.82	55	40	36.9	60	25	3.5	45	0.712	0.024	2.85
11	Mustard Straw	3000	1250	8.22	20	10	8	37.5	120	35	40	0.242	0.05	0.96875
12	Hard White Shaving	2000	1581	5.47	11	10	10	31.62	150	117	30	0.718	0.028	2.110635
	Total							**3314.20**	**3885**	**1584**		**37.047**	**0.576**	**126.3191**

2.2 ANALYSIS OF THE DATA

The data collected from the Purchase Department covers the following items:

- List number and code of each item.
- Description of the items.
- Cost of the items.
- Quantity consumed during 2006-2008.
- Opening and Closing stock of the items of each year.
- Replenishment of the material.

2.2.1 Existing Inventory Parameters for Raw Materials and Boiler Fuels

Tables 4.02.a depict the Existing Inventory Parameters for Raw Materials and Boiler Fuels have been presented in the Annexure I.

2.2.2 Proposed Inventory Parameters for A Class Items (Raw Materials & Boiler Fuels)

Tables 4.03.a, 4.03.b and 4.03.c depict Proposed Inventory Parameters for A Class Items (Raw Materials & Boiler Fuels) with Stock Replenishment having r = 3,5 and 10 years respectively and C_0 = Rs 200/- per order.

Tables 4.04.a, 4.04.b and 4.04.c depict Proposed Inventory Parameters for A Class Items (Raw Materials & Boiler Fuels) with Uniform Replenishment having r = 3, 5 & 10 years respectively and C_0 = Rs 200/- per order.

A comparative look at Table 4.02.a, 4.03.a, 4.03.b, 4.03.c, 4.04.a, 4.04.b and 4.04.c reveals that the critical parameters for r = 3 and r = 5 for most of the items have decreased resulting in improvement in inventory condition. These tables have been presented in Annexure II.

III. EXISTING VS. PROPOSED INVENTORY PARAMETERS, ANALYSIS AND DISCUSSIONS

The critical Inventory Parameters i.e. Safety Stock, Average Inventory cost, Inventory Holding Cost, Inventory Ordering Cost and Total Inventory Cost were computed for the Existing and each of the three Proposed situations i.e. r = 3, 5 and 10 years both for SRM and URM. As first step interse comparison of URM with SRM is done.. The preferred model values have then been compared with the existing values to find the improvement in the respective cases.

Table 4.01.a and Fig. 4.1 give the Existing and Proposed Inventory Parameters for Raw Materials and Boiler Fuels for different conditions.

Parameters	Existing	Stock Replenishment (Proposed)			Uniform Replenishment (Proposed)		
		r = 3	r = 5	r= 10	r = 3	r = 5	r= 10
Safety Stock (Tons)	1584	1084.7 (-31.56%)	1438.7 (-9.17%)	2083.91 (+31.55%)	781.039 (-50.69%)	1192.26 (-24.73%)	2021.69 (+27.63%)
Avg. Inventory Cost (Rs in Lacs)	126.31	47.347 (-62.5%)	60.243 (-52.3%)	84.27 (-33.28%)	56 (-55.66%)	65.628 (-48.04%)	85.865 (-32.02%)
Inventory Holding Cost (Rs in Lacs)	37.047	11.829 (-68.07%)	15.061 (-59.34%)	21.067 (-43.13%)	13.986 (-62.24%)	16.407 (-55.71%)	21.466 (-42.05%)
Inventory Ordering Cost (Rs in Lacs)	0.576	0.942 (+63.54%)	0.816 (+41.66%)	0.616 (+6.94%)	0.79 (+37.15%)	0.74 (+28.47%)	0.675 (+17.18%)
Total Inventory Cost (Rs in Lacs)	163.933	60.118 (-63.32%)	76.12 (-53.56%)	105.953 (-35.36%)	70.776 (-56.82%)	82.775 (-49.50%)	108.006 (-34.12%)

Table 4.01.a Existing and Proposed Inventory Parameters For Raw Materials and Boiler Fuels

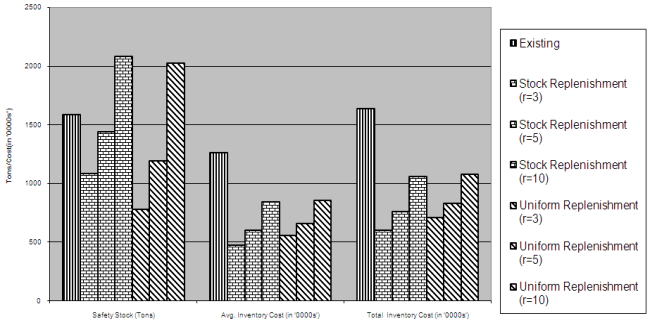

Fig. 4.1 Existing and Proposed Inventory Parameters for Raw Materials and Boiler Fuels

3.1 Raw Materials and Boiler Fuels

A look on the table 4.01a shows that the SRM is preferable over URM in case of Raw Materials and Boiler Fuels in the unit under study, under all the conditions of r =3, 5 & 10 years. The Total Inventory Cost in URM is 70.776 (r = 3), 82.775 (r = 5) and 108.006 (r = 10). The corresponding cost in SRM is 60.118 (r = 3), 76.12 (r = 5) and 105.953 (r = 10). This results in a cost decrease of 17.72%, 8.74% and 1.93% respectively.

As far as the selection of risk of stock out is concerned, comparing the preferred model i.e. SRM values with the existing one, the analysis of the data reflects that for r = 3 years, the safety stock required is 31.56% less than the existing safety stock and further there is a considerable saving of Rs 103.81 lacs in Total Inventory Cost.

For r = 5 years, though the safety stock required is only 9.17% less than the Existing Safety Stock, but this results in an additional cost of Rs 16 lacs in Total Inventory Cost in contrast to r = 3 years condition.

For r = 10 years, the safety stock required is 31.55% more than the Existing Safety Stock. This incurs an additional cost of Rs 29.83 lacs in Total Inventory Cost in contrast to r = 5

years condition.
After discussions with the top and middle management of the organization and considering the cost factors, the company favored the alternative of Stock Replenishment Model for risk of run out i.e. r = 5 years though quantitatively Stock Replenishment Model for risk of run out i.e. r = 3 seemed to be the optimal solution.

IV. INTER SHOP COMMUNICATION

The items can be availed in time from the central store if the central store is informed regularly at the end of each month. They should be informed about excess stock if any, safety stock, stock available with the shop and immediate requirement for the coming month. Those items, which are approaching Reorder Level or are likely to touch Reorder Level in the coming month, should be informed showing priority of the item. For this purpose, a performa can be developed as shown in Annexure VI. and Annexure VII.

4.1 DISPOSAL OF OBSOLETE INVENTORY

The information regarding the excess inventory resulting from the change in design or any other modification should be widely circulated. It should be sent to supplier shop as well as purchase department. This decision regarding their stock in separate bins or their auction can be taken after consultation with the material management staff.

4.2 LIMITATIONS

1. The models have been formulated under a set of assumptions, which may not realize in all situations.
2. The Quantity discounts have not been considered.
3. The study pertains to a particular unit and some of the inferences drawn may be applied to other situations with caution.
4. For data, the researcher is solely dependent upon the company records and officials and hence the accuracy and reliability of the given data limits the accuracy of the results.

V. CONCLUSIONS, RECOMMENDATIONS AND SCOPE FOR FUTURE WORK

The present study has been conducted on a paper mill producing 90 Tons of paper per day. Having come out of the analysis and discussion phase in which policy and models are selected, the parameter estimation and the application of the model have been done. Following major conclusions, recommendations and directions for further work can be made:

5.1 CONCLUSIONS AND RECOMMENDATIONS

Inventory management is a part of the overall management system. Hence, its effectiveness depends to large extent on the working of the total management system. Various sub systems of the organization have to be matched with the inventory control system for the desired results. Also, the inventory control system has been designed taking into account the peculiarities of different sub systems of the organization.

Furthermore the risk of run out becomes a rarity in the system and has been evaluated to take place once in a time span of 3 years, 5 years and 10 years.
The data on materials particularly the inventory level of various classes of materials have been analyzed. The results based on analysis as given in the previous chapter in turn help us to draw the following conclusions:

- Generally the inventory management has not been getting the attention that it deserves considering the volume of the materials processed and the nature of processing.
- There existed a scope for scientific analysis and improvement in the system under study.
- The management by and large was receptive to the suggestions and keen to implement the refinements suggested.
- Categorization of materials, using the pareto analysis and using the deterministic models based on Stock Replenishment and Uniform Replenishment criteria was feasible. This provided alternative combinations of inventory parameters which resulted in cost effectiveness and efficient use of materials.
- In most of the cases i.e. for Raw Materials and Boiler Fuels, Chemicals and MRO's, Stock Replenishment Model (SRM) was found to be more effective alternative and hence it was preferred. From the risk optimization point of view, the company preferred the one in five years run out alternative (i.e. r = 5) for all the categories of materials though quantitatively r = 3 was coming out to be the choice in some of the cases. This was the Management Preference.

While carrying out this study, it was found that the safety stocks kept by Shreeyans Unit are quite high. These have not been worked out scientifically. The recommendations for the new inventory system are as under:

- The inventory management models should be introduced systematically to every sub system in the organization. An appropriate information and documentation framework need to be developed for sensitivity analysis, which must be 'dynamic' and adaptable to change. In order to understand the full impact of inventory management, it is necessary to examine the changes that take place in the organization during the implementation of the proposed models.
- In the Central Store, some components are stocked in excess of requirements. There is need for appropriate control on them and information about the same should be given to the purchase department.

5.2 SCOPE FOR FURTHER WORK

- Some other selective inventory control models like VED, HML and FSN can be used. For this, a careful study of various equipments and parts can be done and few vital parts can be given place in store and other can be treated casually.

- In the present study, the components have been divided into various categories and the safety stocks have been worked out. However, an analysis of 'A' Class items considering the factors like distance of supplier and vendor development can be carried out in further details. A special study can be undertaken for the purpose.
- The comparative study of inventory management with respect to other paper mills in the state may be undertaken, which may subsequently be extended to interstate (national) level.
- Application of JIT, Supply Chain Management and collaborative Forecasting may be undertaken.

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