International Journal For Technological Research In Engineering
Volume 7, Issue 5, January-2020 *ISSN (Online): 2347 - 4718*

CASE STUDY TO PREPARE THE INVENTORY CONTROL MODEL IN PAPER INDUSTRY FOR A CLASS ITEMS

Kushal Kumar[1], Gajender Singh[2]
[1,2]Assistant Professor
Shekhawati Institute of Engineering and Technology, Sikar, Rajesthan, India

ABSTRACT: Inventory on one hand is required for the smooth production run and on the other hand it is also known as "Dreadful Disease of Industry", "Graveyard of Business", "Corporate Obesity" and "a national problem". Inventory Control is today the major profit center.This paper aims at analysis of raw materials and boiler fuel (A class items)for the development of deterministic inventory control models in a paper industry 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 a stock of physical commodity required to meet the future demand having economic value. 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 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.

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.[22]

1.3 OBJECTIVES

PRIME OBJECTIVE

This paper primarily aims at studying the inventory management system of paper mill and suggest improvements.

SECONDARY OBJECTIVES

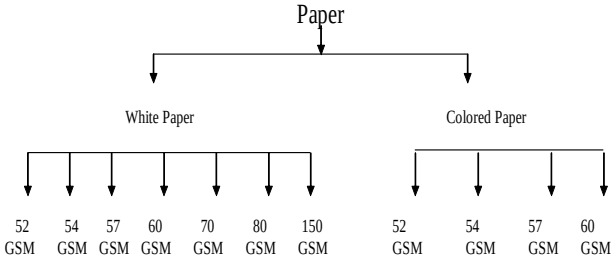
The secondary objectives would be

- To reduce the handling cost.
- To minimize the possibility of Stock Outs.
- To calculate for major items
  - (i) When to Replenish the Stock.
  - (ii) How much Stock to Replenish.
- To strike a balance to maintain proper inventory with the minimum financial impact.

1.4 DESIGN OF THE STUDY

The sequential chart as shown in Fig 1.1 depicts the design of the study and various steps.
The best way to present the design plan is in chart form showing the different activities as shown on next page. A time scale may further be included and the review data may be put to use in future design.

FIG. 1.1 DESIGN OF THE STUDY



II. LITERATURE REVIEW

Due to the impact of inventory management on the cost of the operations and hence the product, inventory has been seeking attention of both the academics and practitioners. Some of the work in the past two decades has been reviewed to understand the concept and trends on this issue.

Sadiwala [1] has done mathematical modeling and simulation studies of inventory control in Material Requirements Planning. For a deterministic demand and lead time the master production schedule (MPS) gives the net requirements and on hand inventory of different components of end product by MRP systems automatically with the help of computer. The various mathematical models have been suggested for the deterministic type of demand and lead time variations to solve the problem, how to reduce the inventories and the investment tied up with them. In this paper, a simple mathematical model has been developed for determining the system cost and reorder quantity. The results obtained from the simulation studies have been presented as the cost of the system for variation in demand and lead-time. The optimum values of reorder point and reorder quantity have been obtained. The results are very useful for decision-making.

White et al. [2] described a project, which aimed to implement an inventory reduction and management plan for a paper industry. Faced with declining sales in a decreasing market, "American Forest and Paper Association (AFPA)" embarked on a thorough inventory evaluation using inventory and historical data, aging analysis and turnover. Among the solutions, included the setting of goals, revisions of automatic replenishment systems, introduction of mathematical modeling techniques and establishment of material management department. It was projected to achieve a 24% reduction in inventory by the end of June 1992. By the end of year 1991, AFPA saw a 16% reduction in 6 months. The ultimate reduction was expected to be 36% despite a projected increase in sales.

Chen et al. [3] investigated inventory models in which the stock-out cost is replaced by a minimal service level constraint (SLC) that requires a certain level of service to be met in every period. The minimal service level approach has the virtue of simplifying the computation of an optimal ordering policy, because the optimal reorder level is solely determined by the minimal SLC and demand distributions. It is found that above a certain "critical" service level, the optimal policy "collapses" to a simple base-stock or order-up to level policy. This shows the minimal SLC models to be qualitatively different from their shortage cost counterparts. This paper also demonstrates that the "imputed shortage cost" transforming a minimal SLC model to a shortage cost model does not generally exist. The minimal SLC approach is extended to models with negligible set-up costs. The optimality of myopic base-stock policies is established under mild conditions.

For the analysis of the problem to be selected the Deterministic Model (Heyhurst - Perpetual Review Model) has been adopted. The reasons for the selection of this model as per the situation in the company are given below: -

- Demand is deterministic and uniform.
- Lead – time is fixed.

Thus, from the presented literature review, in can be observed that deterministic inventory model provides us efficient and economical solutions in ensuring the right and timely availability of materials at promising cost. The approach being followed in the presented ongoing work is Heyhurst formulation, as discussed above for a continuous production paper industry.

III. SELECTION OF THE INDUSTRY

"Shreyans Industries Limited, Unit Shreyans Papers" Ahmedgarh, Distt. Sangrur (Punjab) produces 90 tons of paper per day. It was established in May 1982. Over 1100 employees are serving in this unit. It is having an annual turn over of Rs 175 crores.

The other units associated with Shreyans Group are:

1. Shreyans Industries Ltd. Unit Shree Rishabh Papers, Village Banah Distt. NawanShahar.
2. Shreyans Industries Ltd. Unit Shreyans Spinning, Machiwara. Distt. Ludhiana.
3. Shreyans Industries Ltd. Unit Adhinath Textiles Ltd. Chandigarh Road Mundian, Ludhiana.

The investigator in this case got familiar with the working of the unit, found the existing inventory system experience based, purely judgmental and non-quantitative in nature. The investigator was of opinion that there was a scope for cost reduction with regards to inventory aspects in the unit. Moreover, after getting approval from the top management of the unit, he could have an easy access to the unit, which prompted him to select the inventory management in the unit as his project.

Basic Inputs of the Mill

It utilizes Wheat Straw, Baggase, Rice Husk, Polyester Staple Fiber, Jute Caddy, Sarkanda, Mustard Straw, Saw Dust, Veneer Waste Chips as basic raw materials.

Output of the Mill

The paper, which is manufactured, is used for Photostat, computer printing, Stamp Paper, cream wove/off paper, high bright super printing paper & Ledger paper.

3.1 EXISTING INVENTORY MANAGEMENT POLICY:

The various types of inventory in paper industry are:

1. a) Raw Materials and Boiler Fuels.
   b) Chemicals.
2. Work – in – Process.
3. Finished Product.

3. Maintenance, Repair & Operating Inventories (MRO) i.e. tools, consumables and spares.

The Raw Materials consist of Wheat Straw (65-70%) for which daily consumption is 115 tons, Sarkanda, Baggase, Venner chips, Jute Caddy etc. The storage of raw materials involves a large capital.

Various types of chemicals required for raw material processing are also kept in safety stock owing to their criticality. Some chemicals are kept in stock for about one to two months. Daily consumption report of these chemicals is prepared and sent to purchase department where they are purchased after certain fixed period of time. Thus, to keep chemical inventory, special care is needed to store them, which again needs a lot of capital investment.

Also many items of spare parts are to be maintained with the unit and the cost of each item varies from few rupees to thousand of rupees eg. steel bars, steel angles, welding supplies, bolts pipe fittings etc. The lead-time and stock varies from item to item. Many times, number of spare parts accumulates in the store involving large capital with this inventory.

Thus to maintain the required level of production, large inventory involving high capital investment also needs storing space. In the wake of existing inventory system, there is a need to propose an improved inventory system.

3.2 PRELIMINARY STUDY

Preliminary study of the inventory management in the unit has been done to have a feel of the actual situation as it exists. This was mainly through observation and interaction with the concerned officials. This revealed that the inventory management was not being followed strictly on the scientific lines. There seemed to be over storing of some items and shortage of others.

Hence a need for the formal study of the inventory management was felt and it was taken up accordingly.

Formats for seeking the requisite data were prepared after discussions and then the relevant data was taken up out of the company records and files. This was further supplemented wherever required by discussions with the concerned managers and officials.

3.3 PROBLEM FORMULATION AND METHODOLOGY OF THE STUDY

The study of inventory system in "Shreyans Industries Limited, Unit Shreyans Papers" can be divided into four stages:

(i) Collection of data.
(ii) Analysis of data
(iii) Development of proposed system.
(iv) Comparison of Data for existing and proposed system and finding out the benefits from the proposed system.

3.3.1 Data Collection

1. Data regarding the Raw Materials, Boiler Fuels, Chemicals and MRO, complete description and quantity required for the manufacturing of paper were recorded.
2. Rate/Unit, consumption during the years 2006-2008 along with the demand for 2006-2008 were collected from records available.
3. Data related to the production of paper/day were recorded from the record -keeping department on production floor.
4. Opening and Closing balance stock and Replenishment Quantity for each year were recorded.

Finished Goods Inventory was not considered for the study as the demand has been normally outstripping the supply and there was no more than one weeks Finished Goods Inventory at any time in the unit. The average used to be 2 to 3 days inventory only.

3.3.2 Analysis of Data

1. Average inventory of each component during 2006 to 2008 was calculated.
2. Cost of average inventory, inventory carrying cost and total cost of average inventory were worked out.
3. Application of Selective Inventory Control: - The components are classified into categories based on A B C analysis of Selective Control.

435 items are being used during the processing of paper in the selected organization. Some of them are very costly, some are of moderate cost and some of them are of very low cost. The ABC analysis of selective inventory control has been employed for the work. 80 items (18% of total items) have been identified as A class which constitute 95% of the cost which includes raw materials and chemicals. 355 items (82% of total items) have been identified as B & C Class items, have been combined together and constitute the remaining 5% of total cost. The major emphasis has been laid on the A class items.

3.3.3 Development of New System

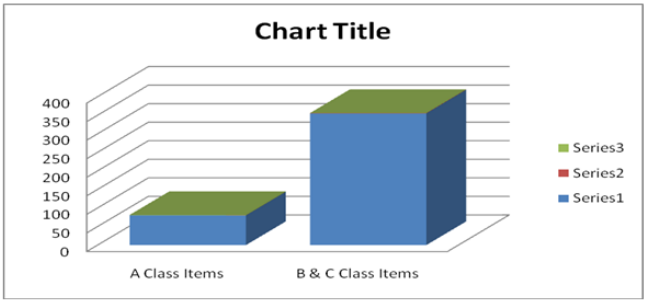
The EOQs, Re-Order Points and Safety Stocks for A, B & C items are worked out mathematically using the model adopted.

3.3.4 Comparison with the Old System

• Calculation of inventory cost and carrying cost with the new system.
• Finding out the differences between the costs of new and old systems.

Furthermore, the proposed inventory system would result in low cost of inventories along with a risk of run out because of shortage of components. A monitoring system will also be set up so that surplus is reduced and crisis because of shortage may be taken care of.The Process Sequence for the Manufacture of Paper in the Unit and Schematic Layout and Process Diagram for Paper Processing has been shown in Fig. 3.1 and Fig. 3.2 respectively on next page.

CLASS	No. OF ITEMS	% AGE OF TOTAL ITEMS IN INVENTORY LIST	%AGE OF TOTAL COST
A	80	18%	95%
B AND C	355	82%	5%



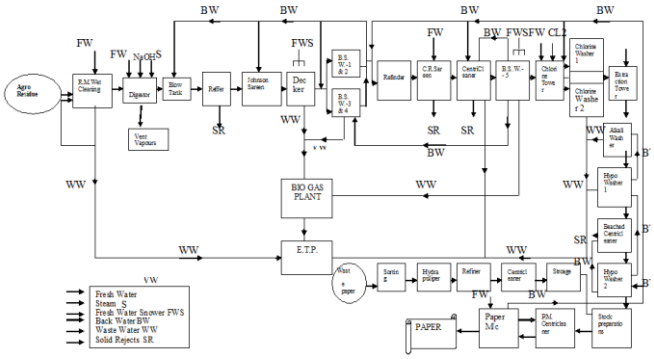


FIG. 3.2 SCHEMATIC LAYOUT AND FLOW DIAGRAM FOR PAPER PROCESSING

3.4 ANALYSIS OF INVENTORY COSTS

As discussed earlier, it is more economical to allow a limited number of stock outs with less stock holding cost than absolute protection against stock out with very high inventory. A mathematical model is prepared to calculate the EOQ, reorder level and safety stock. A risk of stock out year will have to be considered in the analysis. On the basis of historical data & after discussions, the permissible risk of stock run out of 3, 5 and 10 years i.e. one stock out in 3 years, 5 years and 10 years respectively have been taken. On this risk factor EOQ, Safety Stock and Reorder level have been calculated for Raw Materials, Boiler fuels, Chemicals and MRO. After a thorough study of records and discussion with the accounts department of the unit including all the relevant expenses incurred over a period of two years, the inventory carrying cost has been taken to be 25% of items unit cost as shown below.

This cost comprises of 5 components as calculated below:-

Inventory Carrying Cost

- Interest charges on the investment 13%
- Insurance Costs 2%
- Property Taxes 2%
- Storage Costs 2%
- Obsolescence and Deterioration Costs 6%

Total 25%

The ordering cost in the company has been taken to be Rs 200 /- per order for A class items and Rs 180/- per order for B and C class items. The break up for these costs is as follows: -

Ordering Costs for A Class Items

- Salary
  Rs 5,11,000/-
- Travel Expenses
  Rs 35,000/-
- Telephone/Fax Postage Expenses Rs 84,000/-
- Printing Stationary Rs 25,000/-

Total
Rs 6,55,000/-

Total No of Orders per Annum 3284

There fore Ordering Cost per Order = Rs 6,55,000 = Rs199.45/- ≅ Rs200/ -3284

EOQ, Safety Stock and Reorder level have been established for each item .The comparison have been made between recommended inventory level and existing inventory level.

3.5 MATHEMATICAL MODELS FOR INVENTORY CONTROL

Inventory models are the representation of inventory in graphical or analogous form for solution. Such solutions refer to the determination of decision variables, by considering the various aspects of the problem simultaneously. In inventory, the decision variables are EOQ, Safety Stock and Reorder level.

In an industry, a large number of items of different nature are there which require specific treatment from inventory point of view. 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 one of the available methods, a combination of some of the available techniques in addition to innovative control policy has to be applied.

Three Heyhurst [24] models for the paper industry, where an optimization is struck to meet the requirements of paper industry and simplify the complexity of the large items have been selected and used for the present work have been suggested.

The first two models belong to Perpetual Reviewing System where stocks are continuously reviewed. As soon as the total stock level reaches Reorder Point (ROP) procurement action is taken for a fixed quantity equal to EOQ.

Model – I (Perpetual Review System for Stock Replenishment)

The decision variables are given as

$EOQ = [S(10 \times Co/Cu + A)]^{1/2}$

$B = r \times (S/EOQ) A_{dl} / 48$

$P = C_{lmin} + r \times (S/EOQ) A_{dl} / 48$

Where
A = 0.04 A_{dl} r,
A_{dl} = Average daily consumption,
B = Safety Stock,
EOQ = Economic Order Quantity,
Co = Ordering Cost per Order,
Cu = Unit cost of an item,
C_{lmin} = Minimum Consumption during lead time,
P = Reorder Level,
S = Annual Consumption,
r = Permissible risk of run out i.e. number of years in which one risk of run out is permitted,

Assumption made
1) Demand and Consumption are fixed over a period of time.
2) Infinite replenishment rate.
3) Lead Time is constant.
4) Stock replenishment or bulk supply takes place.

Model – II (Perpetual Review System for Uniform Replenishment)

The decision variables are given as

$$EOQ = [5R_R S (2Co + 0.008 C_u A)/C_u (R_R - d_d)] ½$$

$$B = [r x (S/EOQ) -2] / 48 x A_{dl}$$

$$P = C_{lmin} + [r x (S/EOQ) - 2]/48 x A_{dl}$$

Where
d_d = Average Consumption in Lead Time.
R_R = Replenishment Rate,

Assumptions made
1) Demand and Consumption are constant over a period of time.
2) Material is supplied exactly at regular time
3) Lead Time is constant.

This formula will be used for uniform replenishment.

Both the above Inventory models i.e. Model I for Stock Replenishment and Model II for Uniform Replenishment have been applied to A Class items only.

Model – III (Simple EOQ formula with Constant usage rate)

For B and C class items enough information is generally not recorded. More over, as they are numerous in number, it is much more time consuming to analyze their demand or lead time distribution for inventory control purpose

$$EOQ = [2Co S/C_u i] ½$$

Safety Stock is calculated as

B = (Max lead Time – Normal Lead Time / 30) x Monthly Consumption

According to this model, stock is reviewed at the end of each cycle and procurement action is taken for the quantity determined by

P = B + Annual Consumption x Normal Lead Time / 12 x 30

Assumptions made
1) Bulk Supply takes place.
2) The only costs considered are procurement cost and holding cost.
3) Each order is received in a single delivery.

As B and C Class items do not deserve much attention so only simple EOQ formula has been applied for this purpose in their case.

The model as selected is applied to most of the items to serve as a guideline. This also illustrates the mathematical procedure. The solutions are not necessarily optimal for the real situation in "Shreyans Industries Limited, Unit Shreyans Papers" but definitely are less costly than the present policy. The approximate potential savings by following each of the policies have also been calculated in the next paper

REFERENCES

(In chronological order)

[1] Richard, W., White, Miller, and Craig, E. (1992) "Reducing Inventories through Inventory Management", American Production and Inventory Control Society, Vol.26, No. 4, March, pp 595-597.
[2] Frank Y, Chen & Dmitry Krass (1992), "Inventory Models with Minimal Service Level Constraints" European Journal of Operational Research (ELSEVIER) Volume 134 No. 1 Oct, pp 120-140.
[3] Ouyang Liang – Yuh (1996) "Mixture Inventory Model Involving Setup Cost Reduction with a Service Level Constraints" Journals of Operational Society of India (OPSEARCH) Volume 37, No. 4, Dec, pp 327-339.
[4] Khouja M (1997) "The Economic Lot & Delivery Scheduling Problem; Common Cycle, Rework & Variable Production Rate", Journals of American Institute of Industrial Engineers (IIE Transactions) Volume 32, No. 8, Aug., pp 715 – 725.
[5] Nagraj P and Selladurai V (1998), "The Dynamic Lot – Sizing Problem for Multi Stage, Multi – Facility Manufacturing Inventory System", Proceeding of The 14th International Conference On CAD/CAM, Robotics & Factory of Future, Nov. 30 – Dec 1-3, IIT New Delhi, pp 600-606.
[6] Iyengar A.V.K (1987) "Profitability through Effective Inventory Management", Industrial Engineering Journal, Vol. XVI, No. 7, pp 9-13.

