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SHIBAMAY MITRA

National Institute of Technology, Silchar, Assam, India., shibamay07@gmail.com

SUJIT KUMAR PATTANAYAK

National Institute of Technology, Silchar, Assam, India., sujupat@gmail.com

PAPIYA BHOWMIK

National Institute of Technology, Silchar, Assam, India., papiya.nita@gmail.com

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# INVENTORY CONTROL USING ABC AND HML ANALYSIS – A CASE STUDY ON A MANUFACTURING INDUSTRY

SHIBAMAY MITRA<sup>1</sup>, SUJIT KUMAR PATTANAYAK<sup>2</sup> & PAPIYA BHOWMIK<sup>3</sup>

<sup>1,2&3</sup>Dept. of Mechanical Engineering, National Institute of Technology, Silchar, Assam, India.  
E-mail: shibamay07@gmail.com, sujupat@gmail.com, papiya.nita@gmail.com

**Abstract-** Inherent uncertainties in demands and supply make it difficult for supply chains to achieve optimum inventory replenishment, resulting in loss of sales or keeping excessive inventories. An unkept inventory can take up to one-third of an organization's annual investment. Therefore, in order to compete with invariably erratic demands, it is not only challenging to develop an intelligent system to maintain and control an optimum level of inventory but has also become mandatory. Here we have tried to study the inventory control system of an EMU coach manufacturing industry using ABC and HML analysis method.

**Keywords** - ABC analysis, HML analysis, EMU coach, Inventory control.

## I. INTRODUCTION

Here we have applied the inventory analysis techniques on an EMU manufacturing industry. Now to understand the application of the analysis on this particular industry we should have some basic knowledge about the Electric Multiple Unit (EMU) coaches.

An Electric Multiple Unit (EMU) is a multiple unit train powered by electricity. The cars that form a complete EMU set is categorized on the basis of their function into four types – viz. Power Car that carries pantograph, transformers; Motor Car that carries traction motor; Driving Car that containing a drivers cab for controlling the train; Trailer Car that is similar to passenger car in a locomotive hauled train.

A complete rake consists of 9 coaches having 3 units or 12 coaches having 4 units. Each unit consists of one motor coach and two trailer coaches.

Arrangement of a 9 coach rake is in the order as B-C-C-D-B-C-C-D-B and 12 coach rake being B-C-C-D-B-C-C-D-B-C-C-B : where, 'B', 'C', and 'D' represent motor cum trailer coach, passenger coach and vendor cum passenger coach respectively.

The preparing shop of EMU has been divided in to four major sections namely Body Shell where structural framework of the EMU is done i.e. roof, side and end assemblies, Under Frame assembly, Bogie Shop, and Furnishing Shop.

The sub assemblies required for EMU assembly are 1) Roof assembly, 2) Side assembly, 3) End assembly, 4) Under Frame assembly, 5) Bogie assembly. We can categorize the items as a whole else we can categorize them according to the preparation of each sub assembly as well to perform the inventory analysis techniques.

## II. LITERATURE REVIEW

Inventory management is the accurate tracking of all materials in the company's inventory. The company has purchased these items from another supplier. There are three possible areas of loss that are reduced through effective inventory management: shrinkage, misplacement, and short shipments. There are various types of inventory control analysis techniques. Here we shall focus on the following three types of techniques-

### A. Classification Based on Consumption (ABC Analysis)

Class 'A' are the vital few items which may be around 10-15 % of the items contributing towards 60-70% of total consumption value, Class 'B' are the items covering about 20-25 % of total items which account for 20-30 % of total consumption value, Class 'C' are the items covering about 60-70% of the items contributing to 10-15 % consumption value.

### B. HML Analysis (Based on Unit Price)

This analysis is similar to ABC analysis but here the criterion is price instead of usage value. The items in this analysis are classified into three groups, i.e. high, low and medium. The management decides the cutoff lines or prices for the three categories. This analysis helps to keep control over consumption as per the price and helps to assess storage and security requirements, i.e. the high priced items are to be stored in the cupboards. it helps to outline the buying policies to delegate authorities to buyers.

## III. CASE STUDY

Table 1 shows us how an ABC analysis is performed. We should have the following data-Name of the items, Annual demand of each item, Unit price of each item. As shown in the table we have to calculate the percentage annual demand of each item from the

available annual demand data of each item. After that we have to calculate the annual usage of each item.

TABLE I. ABC ANALYSIS OF UNDER FRAME ITEMS

Item	Annual demand	% Annual Demand	Unit Price	Annual Usage	% Annual Usage	% Cumulative Annual Usage	Category
Tube Complete	104	42.97	1029.6	107078.4	29.61	29.61	A
Cap for Side Bearer	16	6.61	5446.48	87143.68	24.10	53.72	A
Bearing Bracket	6	2.47	11471.2	68827.2	19.03	72.76	B
Modified Arrangement of Side Buffer Base	8	3.30	5737.68	45901.44	12.69	85.45	C
Side Bearer Assembly	104	42.97	280.8	29203.2	8.07	93.53	C
Modified Arrangement of Side Buffer Base	4	1.65	5841.68	23366.72	6.46	100	C

Annual usage can be calculated from the following equation-

$$\text{Annual usage} = \text{Annual demand} \times \text{Unit price} \quad (1)$$

From the annual usage we can calculate the percentage annual usage of each item.

The next step is to calculate the percentage cumulative usage of each item. The percentage cumulative usage of the first item is equal to the percentage annual usage of the first item. The percentage cumulative usage from the second item onwards can be calculated from the following equation

$$\begin{aligned} &\% \text{ Cumulative annual usage of 2}^{\text{nd}} \text{ item} \\ &= \% \text{ Annual usage of 1}^{\text{st}} \text{ item} + \% \text{ Annual usage of 2}^{\text{nd}} \text{ item} \quad (2) \end{aligned}$$

The percentage cumulative usage of the remaining items can be calculated from the above mentioned formula.

After that sort the data from the higher values to lower values taking into account the annual usage as the base value

The table used here shows us the inventory analysis of items of a under frame assembly. Similarly we can analyze the items of the bogie assembly, body shell assembly, furnishing stage items, completion stage items as well as all the items required to produce a rake of a Electric Multiple Unit.

The graphs obtained are as follows-

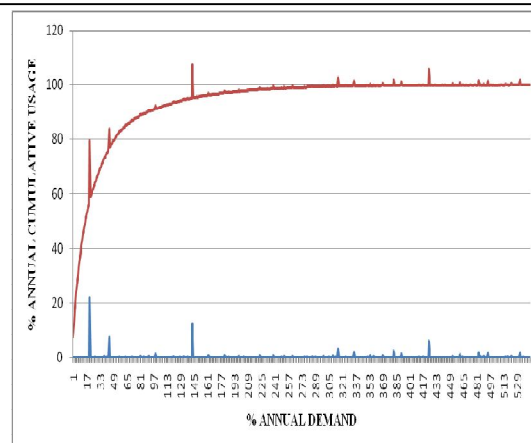


Figure 1. ABC analysis of EMU items

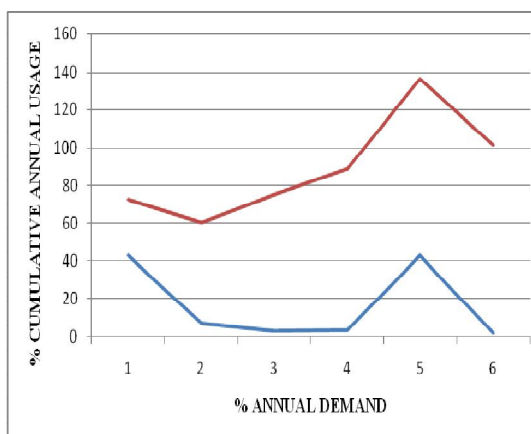


Figure 2. ABC analysis of under frame items

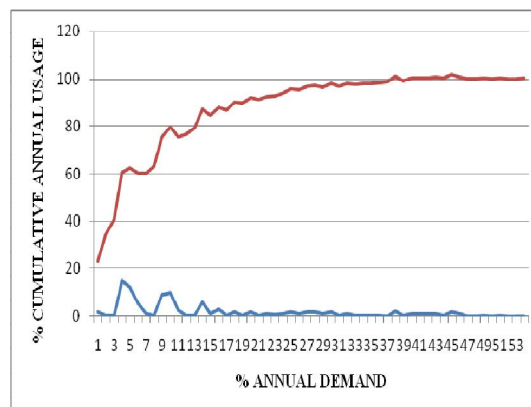


Figure 3. ABC analysis of bogie items

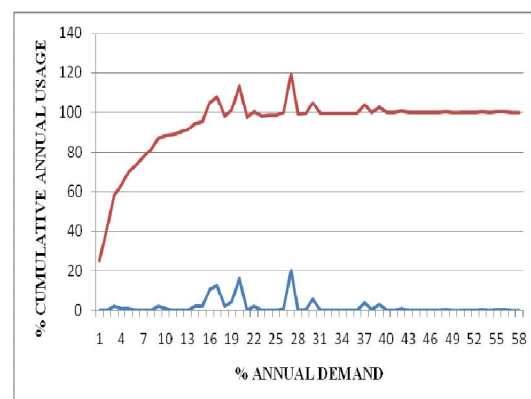


Figure 4. ABC analysis of body shell items

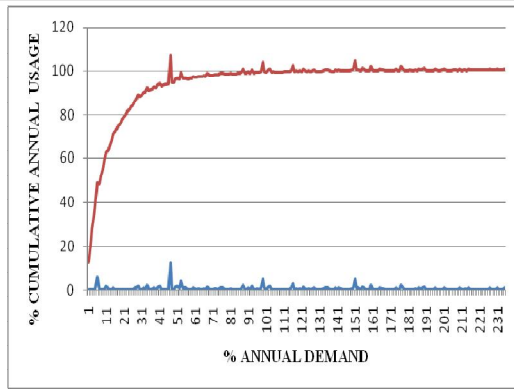


Figure 5. ABC analysis of furnishing stage items

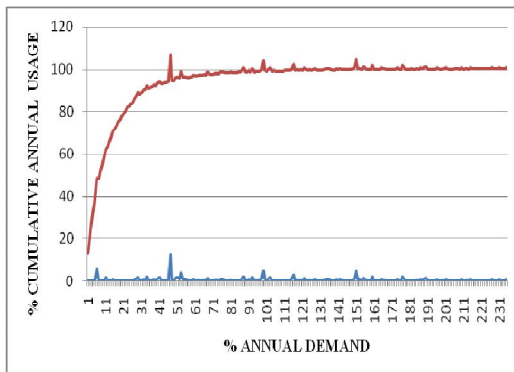


Figure 6. ABC analysis of completion stage items

Table 2 shows us how an HML analysis is performed. We should have the following data-Name of the items, Annual demand of each item, Unit price of each item.

As shown in the table we have to calculate the percentage unit price of each item from the available unit price of each item. After that we have to calculate the annual usage of each item.

TABLE II HML Analysis of Under Frame Items

Item	Annual demand	Unit price	% Unit price	Annual Usage	% Annual Usage	% Cumulative Annual Usage	Category
Bearing Bracket	6	11471.2	38.48	68827.2	19.03	19.03	H
Modified Arrangement of Side Buffer	4	5841.68	19.59	23366.72	6.46	25.50	M
Modified Arrangement of Side Buffer	8	5737.68	19.24	45901.44	12.69	38.19	L
Cap for Side Bearer	16	5446.48	18.27	87143.68	24.10	62.30	L
Tube Complete	104	1029.6	3.45	107078.4	29.61	91.92	L
Side Bearer Assembly	104	280.8	0.94	29203.2	8.07	100	L

Annual usage can be calculated from the following equation Annual usage = Annual demand x Unit price (3)

From the annual usage we can calculate the percentage annual usage of each item.

The next step is to calculate the percentage cumulative usage of each item. The percentage cumulative usage of the first item is equal to the percentage annual usage of the first item. The percentage cumulative usage from the second item onwards can be calculated from the following equation % Cumulative usage of 2<sup>nd</sup> item = % Annual usage of 1<sup>st</sup> item + % Annual usage of 2<sup>nd</sup> item (4)

The percentage cumulative usage of the remaining items can be calculated from the above mentioned formula.

After that sort the data from higher value to lower value taking into account the unit price as the base value.

The table used here shows us the inventory analysis of items of a under frame assembly. Similarly we can analyze the items of the bogie assembly, body shell assembly, furnishing stage items, completion stage items as well as all the items required to produce a rake of an Electric Multiple Unit.

The graphs obtained are as follows-

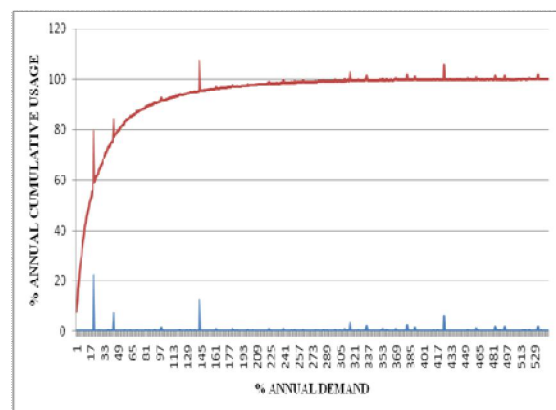


Figure 7. HML analysis of EMU

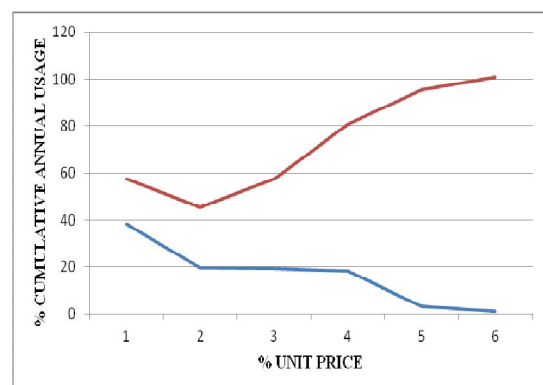


Figure 8. HML analysis of under frame items



Figure 9. HML analysis of bogie items

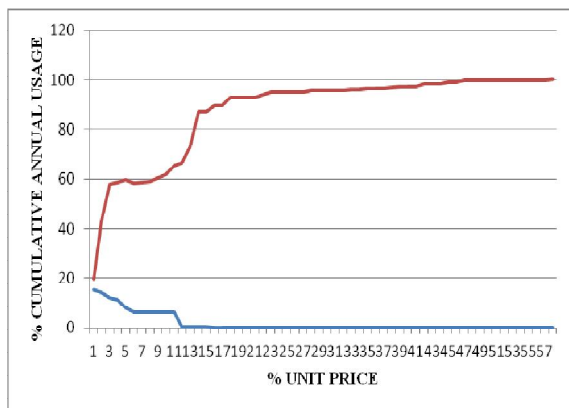


Figure 10. HML analysis of body shell items

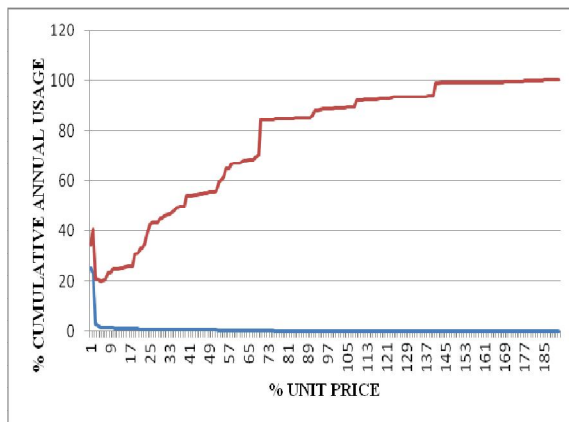


Figure 11. HML analysis of furnishing stage items

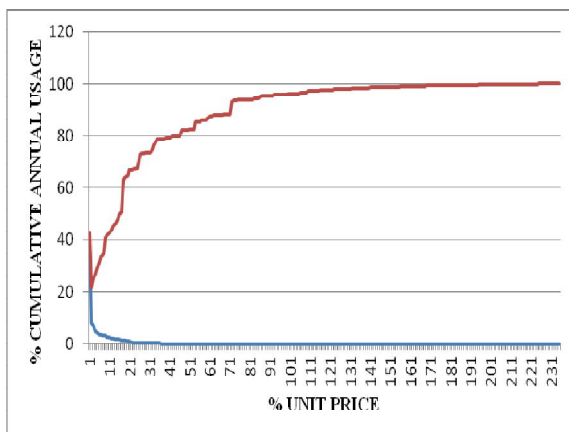


Figure 12. HML analysis of completion stage items

#### IV. ANALYSIS

From ABC analysis of all the items required to manufacture a EMU, it has been found that about 4% of the items are classified as 'A' items which contribute towards 60% of the annual consumption. Further 4% of the items are classified as 'B' items which contribute towards 25% of total annual consumption. The remaining 92% items are classified as 'C' items which contribute towards 15% of the total annual consumption.

From the ABC analysis of the under frame items we have found that about 33% of the items are classified as 'A' class items which contribute towards 60% of the total annual consumption. About 17% of the items are classified as 'B' class items which contribute towards 25% of the total annual consumption. The remaining 50% items are classified as 'C' class items which contribute towards 15% of the total annual consumption.

From the ABC analysis of the bogie items we have found that about 13% of the items are classified as 'A' class items which contribute towards 60% of the total annual consumption. About 17% of the items are classified as 'B' class items which contribute towards 25% of the total annual consumption. The remaining 70% items are classified as 'C' class items which contribute towards 15% of the total annual consumption.

From the ABC analysis of the body shell items we have found that about 5% of the items are classified as 'A' class items which contribute towards 60% of the total annual consumption. About 10% of the items are classified as 'B' class items which contribute towards 25% of the total annual consumption. The remaining 85% items are classified as 'C' class items which contribute towards 15% of the total annual consumption.

From the ABC analysis of the furnishing stage items we have found that about 5% of the items are classified as 'A' class items which contribute towards 60% of the total annual consumption. About 10% of the items are classified as 'B' class items which contribute towards 25% of the total annual consumption. The remaining 85% items are classified as 'C' class items which contribute towards 15% of the total annual consumption.

From the ABC analysis of the completion stage items we have found that about 4% of the items are classified as 'A' class items which contribute towards 60% of the total annual consumption. About 7% of the items are classified as 'B' class items which contribute towards 25% of the total annual consumption. The remaining 89% items are classified as 'C' class items which contribute towards 15% of

the total annual consumption. From the graphs it has been observed that the graph showing the ABC analysis process of the under frame shows a little bit of deviation compared to the other graphs. This is due to fewer number of items of the under frame assembly.

From HML analysis of all the items required to manufacture a EMU, it has been found that about 1% of the items are classified as 'H' items which contribute towards 15% of the annual consumption. Further 1% Of the items are classified as 'M' items which contribute towards 10% of total annual consumption. The remaining 98% items are classified as 'C' items which contribute towards 75% of the total annual consumption.

From the HML analysis of the under frame items we have found that about 17% of the items are classified as 'H' class items which contribute towards 15% of the total annual consumption. About 17% of the items are classified as 'M' class items which contribute towards 10% of the total annual consumption. The remaining 66% items are classified as 'L' class items which contribute towards 75% of the total annual consumption.

From the HML analysis of the bogie items we have found that about 4% of the items are classified as 'H' class items which contribute towards 15% of the total annual consumption. About 4% of the items are classified as 'M' class items which contribute towards 10% of the total annual consumption. The remaining 92% items are classified as 'L' class items which contribute towards 75% of the total annual consumption.

From the HML analysis of the body shell items we have found that about 2% of the items are classified as 'H' class items which contribute towards 15% of the total annual consumption. About 2% of the items are classified as 'M' class items which contribute towards 10% of the total annual consumption. The remaining 96% items are classified as 'L' class items which contribute towards 75% of the total annual consumption.

From the HML analysis of the furnishing stage items we have found that about 4% of the items are classified as 'H' class items which contribute towards 15% of the total annual consumption. About 6% of the items are classified as 'M' class items which contribute towards 10% of the total annual consumption. The remaining 90% items are classified as 'L' class items which contribute towards 75% of the total annual consumption.

From the HML analysis of the completion stage items we have found that about 1% of the items are classified as 'H' class items which contribute towards

15% of the total annual consumption. About 1% of the items are classified as 'M' class items which contribute towards 10% of the total annual consumption. The remaining 98% items are classified as 'L' class items which contribute towards 75% of the total annual consumption.

From the graphs it has been observed that the graph showing the ABC analysis process of the under frame shows a little bit of deviation compared to the other graphs. This is due to fewer number of items of the under frame assembly.

## V. CONCLUSION

Inventory Analysis and Control has become inevitable for a manufacturing industry. In order to refrain from having an inventory go dead it is of utmost importance to stay abreast with the number and condition of items in that particular inventory. In this regard both periodic and continuous techniques can be used for appraising the stats of the stocks. Once the figures are accurately determined it is yet again very important to be able to further determine the level at which a particular item's stock needs to be maintained. For which calculations and analysis are mandatory. The case study discusses ABC and HML analysis methods of inventory control analysis of a Electric Multiple Unit manufacturing industry.

From the above study we have found that the priorities of the items changes according to different inventory analysis techniques. The management of the company decides which process to follow taking into account their budget, supply, demand, inventory carrying capacity etc.

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