

Application of Selective Inventory Control Techniques for Cutting Tool Inventory Modeling and Inventory Reduction-A Case Study

A K Madan ^{*}, Ranganath M S

Department of Mechanical Engineering, Delhi Technological University, New Delhi, India

Article Info

Article history:

Received 29 December 2013

Received in revised form

10 January 2014

Accepted 20 January 2014

Available online 1 February 2014

Keywords

ABC

VED

JIT

Selective inventory control

Inventory reduction

Abstract

The study shows the need of inventory control and inventory reduction in the industries. It shows the importance and need of Zero inventory (JIT system) in the industries. In this work ABC and VED selective inventory control techniques are applied for cutting tool inventory modeling in an industry. It was suggested that the conventional inventory model formulated as per their convenience is not very effective. A 2-D matrix of the ABC-VED analysis has been constructed for inventory modeling to achieve high efficiency. For Inventory reduction Ageing analysis, Analysis of Scrap and Lead Time analysis was carried out on the cutting tools. The results showed that there are a number of items present as scrap and a lot of items are just being accumulated and are not in use. It was suggested that to sell off the scraps and extra unused items in order to reduce the inventory holding costs and empty the space which have been un-necessarily being occupied. Feasibility of JIT system was carried out for the cutting tools and it was found that it cannot be applied to the plant. The reasons for the same were stated. The research helped the company to understand their current inventory model and the failures of the model. The study helped them to examine their inventory more effectively and hence later it helped them to reduce the inventory which added increased productivity, business growth and reduce the losses.

1. Introduction

The purpose of the project is to create a definite structure of cutting tool inventory modeling and quantity for the cutting tools in the company. An ideal model for the cutting tools such as hobs, cutters, broaches was determined by using the selective inventory control techniques along with it, the quantity of the tools that must be available at a time are also determined. The purpose is also to reduce the inventory of the cutting tools both non-moving and moving. This will directly lead to reduction of inventory cost and shelf space in the organization. In the process, the actual and promised lead time of the vendors were compared, which was used for checking the feasibility of the current system with the application of JIT in the plant. The project covers

all the Hobs, Cutters and Broaches that have been used in the company in the last 1 year time but the ones before that have not been included. Also due to lesser inventory the tools such as milling cutters and drills have not been added. Other than cutting tools, a major part of the inventory is covered by items such as Jigs and Fixtures, but my project is restricted to cutting tools only. The project covers the financial and operational aspect of inventory modeling. The consumption of cutting tools depends on the demand of the different types of Gears, thus there is no particular fast and slow moving inventory in the company for a consistent period. Thus we are not considering the materials aspect or modeling. The study is restricted to cutting tools. It does not consider the other tools such as fixtures and drills. We are not taking milling cutters and drills into account. We have assumed that the lead time and the cost of tools are

Corresponding Author,

E-mail address: ashokmadan79@gmail.com

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constant. We also assume that every Hob can be re-sharpened 30 times which is not always true. In ABC analysis instead of considering the exact holding cost, we will consider the purchase cost of the tool. In lead time comparison, we will only take a sample of tools and not all the tools.

2. Literature Review

The variety of research in the field of inventory theory is very huge. In this a brief literature survey is given which gives reviews on various reports of inventory control practice in the form of case studies published in academic journals. In the following paragraphs, a view about application of selective inventory control techniques for inventory management has been discussed. During the last decades, a number of inventory control case studies have appear in the academic literature, reporting applications mostly in the electronics, chemical, and automotive industries. One of the earliest such publications is by Gelders and van Looy (1978) (4), who present various inventory policies both for slow-moving and fast-moving items in a petrochemical plant with around 22,500 SKUs. Vereecke and Verstraeten (1994) (5), described an algorithm for the implementation of a computerized inventory management system for spare parts in a large chemical plant, located in Belgium. The spare parts inventory contains about 34,000 different types of items, 90% of which have demand frequency lower than 4 times a year. Prakash, Ganesh, and Rajendran (1994) (6) used the AHP to evaluate the criticality of spares. Their approach was to categorize the parts using a variety of partitioning techniques that complemented the use of good forecasting procedures including ABC analysis, FSN analysis and VED analysis. Anwaruddin T., Abdul Q.L., & Ghulam Y.S, (2000) (7), presented ABC Analysis to control the inventory costs associated with spare parts store of a service industry and suggested about the past inventory problems are due to the congestion of spare parts and use of inappropriate computer package. Ghobbar and Friend (2003) (8) dealt with techniques applicable to predicting spare parts demand for airline fleets. They tested 13 forecasting methods and devise d a predictive error-forecasting model which compared and evaluated forecasting methods based on their factor levels. Caglar, Li, and Simchi -Levi (2004) (9) studied a spares inventory problem faced by a manufacturer of electronic machines with expensive parts that were located at various customer locations. Assuming that parts failed infrequently according to a Poisson process, he formulated a model

to minimize the system-wide inventory cost subjected to a response time constraint at each field depot. R Gupta, K K Gupta, B R Jain and R K Garg (2007) (10), applied ABC and VED analysis for inventory control in medical stores. An ABC-VED matrix was constructed for economic analysis of drug expenditure of priced vocabulary of medical stores (PVMS) section 01 for the year 2003 of a 190 bedded service hospital was done. By this they were able to control and reduce the inventory to a large extent which ultimately increased their profits.

3. Selective Inventory Control

Expansion of industries has been the major goal of the industries. Companies are trying to expand their production, sales etc. in order to stand in the global market. The expansion has resulted into the expansion of various activities of the industry. This in-turn increases the number of items to be purchased and hence, their upkeep has also increased significantly. Purchase and control of the items before their use, irrespective of their usage value, price or procurement problems, is therefore uneconomical. Industries store a number of different types of items. The stored items can be classified as follows:

1. Items needed for production which directly enters the finished product which is marketed to the customers.
2. Maintenance spares needed for keeping production machines in running order.
3. Supplies needed for operations such as lubrication oils, cotton waste, etc.
4. Office equipment to carry the company's transactions smoothly.
5. Furniture, fans, lights, etc. to keep workplace in order.

The criteria for inventory and stock control for various classified items are bound to be different. Various researches done in this field has revealed that various objective functions are needed to keep inventories of all these varieties of items. For this purpose selective treatment has to be given to these items and hence "**Selective Inventory Control techniques**" were used to classify inventories of these items. These Inventory Control methods are based on the principles that it is impossible to manage and control every item in inventory holdings in the same way and skill so as to meet the two broad objectives of inventory control i.e. to reduce investment in inventories, and to avoid stock outs and shortages. Selective inventory control management therefore concentrates on those items where it is justified either

due to essentially or amount of money involved. Selective control means variations in the method of control from inventory class to class based on its classification. The criterion used for the purpose is annual usage value criticality, lead time, consumption rate, procurement difficulties, etc. Selective inventory control has been divided into 9 categories. The table below shows the various categories along with their respective criteria (1).

4. Case Study on Cutting Tool Inventory Modeling and Inventory Reduction

A case study has been illustrated which was carried out in “**Action Construction Equipments (ACE) Limited**”. In this case study “**ABC and VED**” techniques of selective inventory control are applied in the industry for “**Cutting Tool Inventory Modeling and Inventory Reduction**”.

Cutting Tool Inventory at ACE Limited

The cutting tools in ACE Limited are mainly of 4 types namely Hobs, Gear Shaper Cutters, Shaving Cutters and Broaches.

Table: 1. Selective Inventory Control Categories and Criteria

S No.	Category	Criteria	Application
1.	ABC Analysis	Annual usage value (consumption rate*Price Rs/piece)	For materials which go into Production
2.	HML (High, Medium, Low) Analysis	Unit Price	To keep in check high cost items
3.	VED (Vital, Essential, Desirable) Analysis	Criticality or loss of production	For controlling maintenance of spare and manufacturing equipments.
4.	SDE (Scarce, Difficult, Easy) Analysis	Procurement difficulties: geography, reliability, etc. Source of Procurement	To keep vigil on availability, should be kept in stock keeping in mind difficulty of procurement and may follow forward buying
5.	GOLF (Govt., Ordinary, Local, Foreign) Analysis	<ul style="list-style-type: none"> ➤ Govt.-lead time more for retrieval, advance payment ➤ Foreign-procedure long, through bank, port, permission, duty, etc. 	Government supplies need patience to get material, canalizing agency can be used, foreign procurement lead time factor counts
6.	SOS (Seasonal, Off-Season) Analysis	Soya bean, farm produce, high off season price, low in harvest season	Should buy in harvest season to get price advantage and good quality supply
7.	FSN (Fast, Slow and Non-moving) Analysis	Issues from stores give idea. Dispose off non-moving inventory	Fast moving items should be kept in high levels
8.	XYZ Analysis (use for 2-D study)	Closing stock value of inventory at the time of physical stock verification	A category status, e.g. A category in X: Watch C category in X: Reduce stocks
9.	MUSIC-3D (Multi-Unit, Selective, Inventory, Control) Analysis	The control criteria of 3- dimensions are finance operations and materials	Can be used for all varieties of materials. It is a combination of all the above analysis.

Hobs: These are the most important cutting tools used. It is used to cut teeth's in a gear by a process called Hobbing.



Gear Shaper Cutter: As the name suggests, these are used in the shaping process of gears.



Shaving Cutter: This is used in Gear shaving, which is a finishing process.



Broaches: This is another kind of cutting tool used for material removal.



There are mainly two kinds of stores in ACE Limited

- **Main Store-** In the main store, the new and unused cutting tools are kept. For the purpose of

usage, the tool crib issues tools from main stores when required.

- **Tool Crib-** It is the WIP store in which semi used, broken or scraped tools are present. When not on the machine, a cutting tool is deposited in the tool crib.

Present Inventory Model

ACE Limited follows a very basic inventory model. According to the present model, the number of Hobs present in the main store depends on the number of settings in which the hob is used. If the Hob is used in a single setting, a quantity of 2 hobs is kept in use at the tool crib and 2 more hobs are available in the main store. It varies in a similar way with the increase in number of settings.

Whenever there is a decrease in the level of hobs in the tool crib due to consumption or breakages and one of the available hobs in the main store has to be issued, the hob is reordered. Thus ACE Limited follows a fixed order type of inventory model. Thus the re order point for them is 1 tool per setting in the main store.

For Gear Shaper Cutter, 2 cutters are available in the main store and the cutters available in tool crib vary from 2-5 according to the usage.

For Shaving cutter and Broach, there are usually 1 tool each, present in tool crib and main store.

ABC at ACE Limited

Source of data- purchase orders since May 2009

Assumptions

- Holding cost is directly proportional to the cost of inventory
- The cost used is the net price, which includes discount as well as taxes and duties.
- Since these tools have been purchased buy different vendors in different times, we are taking the current price of the tools.

Limitations

- Data taken is for last 10 months only
- Exact holding cost is unknown

The following is the list of the tools categorized into A, B and C. There has been done a separate ABC analysis for all the different types of cutting tools. After every type of tool, the recommendations are given.

ABC Analysis for Hobs

Recommendations for Hobs

- A. There are 11 hobs lying in this category, since the cost of these hobs are higher than the others, their holding costs will be much higher if we keep them in store for a longer time. Thus it is recommended

that these hobs are not kept in the store for long, therefore should be ordered in small quantities.

- B. There are 33 hobs in this category. They are priced in between A and C. Their holding cost will be lesser than A but still be on a moderate side. Thus these hobs should be ordered to requirement and the quantity in store should be between 1 and 2.
- C. There are 42 hobs in this section. They are the least expensive hobs and thus have minimum holding cost. The company can afford to order larger quantities of these tools.

Conclusion

The hobs have a lot of variation in the cost. Thus the ones in category A should be in least quantity and the ones in C can be kept in higher quantities if demanded.

ABC Analysis for Gear Shaper Cutters

A

S No.	ED No.	Teeth	Net price
1	5102	20	41975.00
2	7013AA	20	36455.97
3	7712	19	29371.50
4	5326/5334	21	29001.28

B

S No.	ED No.	Teeth	Net price
1	2014	27	25012.50
2	2015	33	25012.50
3	6102	18	24933.70
4	5301	16	22361.93
5	5335	28	22137.50
6	7007/7005	28	22137.50
7	7013	20	20125.00
8	5387	16	18637.50
9	2046	17	18425.00

C

S No.	ED No.	Teeth	Net price
1	5319	42	17670.00
2	5311	42	17601.55
3	5319	13	16057.44
4	5327	78	14375.00
5	5334	78	14375.00
6	5335	78	14375.00
7	6108	16	13921.25
8	2014/2015	36	12825.00
9	6102	10	11423.75
10	2009	42	10710.00
11	7027	42	9025.00
12	2035	18	8547.00
13	2035	34	8519.50
14	7026	39	7837.50

Recommendations for Gear Shaper Cutters

- A. There are 4 cutters in this category, out of which 7013AA was a specially ordered tool, thus is not regularly ordered. For the other 3 cutters, the order level and the quantity in store is recommended to be not more than 1.
- B. There are 9 cutters in this section. The holding cost is moderate and thus the order quantity and stock can vary between 1 and 2.
- C. There are 14 cutters in this category. The holding cost is low. So the order quantity can be high. But Gear Shaper Cutters have very long life, thus we can keep a lesser quantity of these tools.

Recommendations for Shaving Cutters after ABC Analysis

- A. There are 8 cutters in the category. They are high priced, thus have high holding cost. They also take a lot of shelf space due to their size. Thus it is better to keep a lesser quantity of such tools. One at a time is recommended
- B. There are 18 items in this list. The holding cost is again on a higher side so it is better to keep a quantity of 1 at time.
- C. There are 26 items in the list. Though the prices are comparatively lower, they are still on a higher side, thus the quantity of 1 is preferred.

Recommendations for Broaches

- A. There are 2 broaches in the category. They are priced near to Rs. 1 lacs thus have extremely high holding cost. Thus the broaches should be made available on demand and only unit quantities should be there in the stores.
- B. There 5 broaches in the list which are also fairly priced and have a high holding cost, thus it is recommended to be kept in unit quantities too.
- C. These too are highly priced except the ones in the bottom. Thus leaving the bottom ones, the others should be kept in least quantities

VED at ACE Limited

Source of data -Issue list from SAP.

Assumptions

- The tool issued was used or is in use.
- Due to variability in life of tools, we consider issue as the representation of criticality.

Limitations

- Data taken is for last 1 year and 3 months only
- Some tools used for trial purposes were neglected

The following is the list of the tools categorized into V, E and D. There has been done a separate VED

analysis for all the different types of cutting tools. After every type of tool, the recommendations are given.

VED Analysis for Hobs

V Used More Than 4 Times

E Used 2 to 3 Times

D Used Just Once.

Recommendations for Hobs

V- There are 11 items in the list. Here hobs like 7453 and 7018 have been in use regularly. So it is better to follow the existing model for them. But for the items with around 4 units of consumption, only 1 hob can be present in the main store.

E- There are 17 items in the list. They are moderately used items thus are not very critical. Therefore 1 unit quantity in the main stores and 2 units at setting may be enough.

D- There are 38 items in the list. These are rarely used items. Single units of these in both tool crib and main store would be enough

VED Analysis for Gear Shaper Cutters

V is More Than 3 Units

E is 2 Units

D is 1 Unit

VITAL

S No.	ED No.	TEETH	ISSUES
1	5353		3
2	7007		4
3	5319	13	3
4	5335	28	3
5	7013	20	3
6	5301	16	3

ESSENTIAL

S No.	ED No.	TEETH	ISSUES
1	2003	31	2
2	7027	42	2
3	5334	78	2
4	7026		2
5	5316		2
6	2015	33	2

DESIRABLE

S No.	ED No.	TEETH	ISSUES
1	5302	62	1
2	7716	78	1
3	2006	26	1
4	2004	26	1
5	5354	78	1
6	5311	42	1
7	2009		1
8	5326	21	1
9	2017	53	1
10	2014	27	1
11	2016	51	1
12	5301	14	1
13	7004	78	1
14	5112	20	1

Recommendations for Gear Shaper Cutters

V- If we look at the vital items we observe that in the time period of more than one year, only a maximum of 4 cutters of a particular components are used, which is not a very large quantity. We also know that cutters have longer life so we can still afford to reduce the amount of hobs present in main store to 1. We continue to use larger quantities at tool crib because these tools can be re coated and re used.

E- The desirable items are also very less frequently issued thus it is enough to keep unit stock in the main store and keeping the tool crib inventory as the existing one.

D- The quantity is too less thus unit stock at main store and tool crib will do.

VED Analysis for Shaving Cutters

V is 3 Units

E is 2 Units

Recommendations for Shaving Cutters

V- There is only 1 cutter which was issued thrice in the last year. Thus we can afford to keep this cutter in a quantity of 2 in the tool crib and in unit quantity in the main store.

E- There are 2 items in the list. But we can afford to keep them in unit quantities

D- It is preferable to keep them in unit quantity both in main store and in tool crib.

VED Analysis for Broaches

V is 3 Units

E is 2 Units

D is 1 Unit

Recommendations for Broaches

V- No item could qualify as vital

E- There are 5 items which partially qualify as essentials but even these are used only in quantity of 2. Thus it is not very important have them in excessive stock. Unit quantities will be enough.

D- There are 14 desirable items which have only been used once. No special care is needed for such items and unit quantities of all will be sufficient.

D Matrix Model

Till now we looked at the financial and operational aspect individually. Now we will try to merge both the aspects by forming a 2-2 matrix between holding cost and criticality of the tools.

Source of data - From the data of ABC and VED analysis

Limitations

- Data is for a limited period
- We are only including the tools present in both the analysis.

PRICE	
1	2
High Price and Low Usage	High Price and High Usage
3	4
Low Price and Low Usage	Low Price and High Usage
USAGE	

Recommendations for each Matrix

1. For high priced and low usage tools, we must keep as less quantities as possible because they will be used less frequently and will cost higher to the company. For such tools even JIT can be used if possible. Unit quantities of such items are ideal.
2. For high priced and high usage items, there has to be a standard that has to be followed. Here we cannot afford to keep the quantity less and if we exceed the quantity the cost increases. Thus we must have a fixed re-order point for such items. We must keep some buffer for such items
3. Low priced and low usage items should also be kept in lesser quantities. Since the usage is low, higher quantities will only add to the holding cost.

4. These are the most important items in the company. Special care should be taken for such item. It is recommended to keep proper buffer for such items as the holding cost will also be minimum.

Phase -2 Inventory Reductions

5.4.1 Introduction

Inventory reduction is one of the most important functions of the company. It is essential so that the company does not incur losses and the extra shelf space occupied by the un-used inventory can be eliminated. The space thus obtained can be used for other purposes. Proper inventory modeling leads to inventory reduction. A proper inventory model shows what all parts should be present in the inventory and in what quantity, hence by analyzing the results of inventory modeling inventory reduction can be achieved.

In this work inventory reduction has been done in three ways. They are:

- Ageing Analysis
- Analysis of Scrap
- Lead Time Analysis

Ageing Analysis

Ageing analysis is basically an inventory reduction tool in which the inventory is segregated according to the duration of time since the material is kept in stores without being used. The analysis is mainly done for the reduction of stationary inventory. The inventory which has been kept since a long duration of time is either obsolete or is a very rarely used item. If the inventory is obsolete it either has to be modified and used or must be re-sold. For the rarely used items it is recommended that the no extra stock of those must be present in the store.

In the following analysis we have observed the items which have not been in use since the beginning of year 2009. Following are the different cutting tools that are not used in the inventory. The quantity given is the sum total of those in the tool crib as well as in the main store.

Source of data- Tool crib and Main store Inventory.

Conclusion

The obsolete items mentioned above are in fact blocked money and the company has been bearing the holding cost of such items. Also, they are consuming a lot of shelf space in the stores which actually can be utilized for better purposes. Thus the above materials should either be modified or used or should be sold.

Analysis of Scrap

Scrap is referred to as the material which has been 100% consumed or is broken or chipped off in

such a way that it cannot be used further. Such materials are of no use to the company. They can neither be modified nor be re used. Thus the only option remains is to sell off such inventory, so as to increase the shelf space in the stores.

Following are the quantities of each type of scrap in the tool crib.

Source of Data - Count of the scraps in shelves in the tool crib.

S No.	Cutting Tool	Qty.
1	Hobs	144
2	Gear Shaper Cutter	28
3	Shaving Cutter	20
4	Broach	6

Lead Time Analysis

Lead time is the time taken in procurement of a material. It is the time between the ordering of that material to the time it is retrieved. Lead time is a very important factor in cutting tool inventory because the production of gears depends on the availability of cutting tools. If the cutting tools are not available in the stores when required, it will stop the production and will cause monetary as well as goodwill loss to the company.

Following is the variability of the lead times of various tools and vendors.

Source of data- Record of purchase orders of 2010.

Assumption- It is assumed that the promised lead time of the vendors is 8 weeks.

Limitation- Only a sample of 25 orders was taken and of a limited period of time.

Feasibility of JIT

JIT is the Japanese tool in which the raw material reaches the machine only when it is required. There is no extra inventory present in the stores. For such a system to be implemented, discipline from Vendor's end is a must. JIT has been beneficial to various industries as it has helped them in reduction of inventory, cost and increase production.

Here we are going to check the feasibility of application of JIT for cutting tools in the plant. Looking at the lead time, and the consumption pattern of the tools, JIT does not seem feasible in the following plant due to the following reason:

- Lead time of the vendors are variable, whereas in JIT the material must reach the plant exactly on the time it is required.
- Cutting tools are made to order products. There is no ready-made one present with the vendor, thus ordering requires perfect planning.
- The production is dependent on the daily demands of the heavy vehicles division of the company.
- Life and consumption pattern of tools vary significantly.
- There are problems such as breakages of tools which are sometimes not in human control. Thus a buffer stock of some tools is mandatory.

5. Conclusion

Globalization and industrialization has led to great advancements in the industries. Inventory which was a necessity for the industries has now being considered as one of the waste.

The study shows that in order to survive in this growing environment industry has to seek for measures for inventory elimination or inventory reduction. This has enabled the managers to design an appropriate inventory management or inventory modeling system which would keep track of the entire inventory and hence help in reducing them.

Zero inventories have been achieved by the use of JIT manufacturing system which was first introduced by the Japanese. But still the industries are not able to adapt to JIT because of its competitiveness. The industries are still using the older forms which incur huge amounts of money in the inventory.

The overall study reveals the need of inventory modeling and inventory reduction in the industries. It gives the various inventory modeling and inventory control methods that can be used for managing the inventory. The literature review gives the effectiveness of the selective inventory control methods and shows their reliability for the same purpose.

The study also reveals that the company was not operating with maximum efficiency. In order to increase their efficiency it was suggested to them to use the inventory control techniques.

Then a case study was carried out in the industry in which cutting tool inventory modeling and inventory reduction was achieved by using ABC and VED analysis. By combining the two techniques a 2-D matrix was formed and cutting tool inventory modeling was done. The results of the analysis have been shown earlier. The use of this technique was found very effective and efficient. The results thus

obtained were satisfactory and helped the industry to improve their present inventory model to a large extent. After that Ageing analysis, Analysis of Scrap and Lead Time analysis was done on the cutting tools which helped in reducing the inventory of the industry.

The results of the study were very helpful for the industry. They were able to monitor their inventory and measures were taken to rectify the flaws and reducing the inventory. Inventory reduction helped them in getting the space that was getting wasted by unused inventory and also capital which was wasted to maintain the inventory also reduced and added to

the growth of the business. Feasibility of JIT in the plant for cutting tool of the industry was also done. But it was found that this was not possible due to the following reasons:

- Lead time of the vendors are variable, whereas in JIT the material must reach the plant exactly on the time it is required.
- The production is dependent on the daily demands of the heavy vehicles division of the company.
- There are problems such as breakages of tools which are sometimes not in human control. Thus a buffer stock of some tools is mandatory.

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