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MULTI UNIT SELECTIVE INVENTORY CONTROL- THREE DIMENSIONAL APPROACH (MUSIC 3D) TO INVENTORY MANAGEMENT- A CASE STUDY

Dr. Sengottuvelu C

Abstract

This paper focuses on application of selective inventory control techniques namely, ABC, FSN SDE, and MUSIC-3D analysis in warehouse inventory management of traded parts. MUSIC-3D approach was applied by combining all the three techniques namely, ABC, FSN and SDE analysis. Inventory is classified into raw materials, work-in-progress, finished goods, spare parts and MRO items. Inventory is the life line of any manufacturing company in many ways. Inventory plays an important in increasing profitability and return on investment. So, inventory should be managed properly. Supply chain management is all about managing demand and supply. One of the important component in any supply chain is inventory. The main objective of this paper is to administer single dimensional inventory techniques and three dimensional approach in managing traded parts inventory. This study was conducted at Auto Connection Systems Company in Kerala, India. Primary data was collected by pooling data from their ERP- SAP system. The company handles about 720 traded parts. All the 720 traded parts are considered in this study. Firstly, ABC classification, FSN and SDE analysis are conducted individually. Then, 3D analysis was conducted by combining all the three inventory control techniques. It is recommended that the company should exercise strict control on 'A' class items, Non-moving items, and Scarce items. Moderate control on 'B' class items, Slow moving items, and Desirable items. Less control on 'C' class items, Fast moving items and, Essential items.

Keywords: Inventory control techniques, ABC, FSN, SDE, MUSIC 3D analysis, traded parts.

1. INTRODUCTION

The term inventory refers to the materials / inputs or goods used by a firm for the purpose of production and sale. It also includes the items, which are used as supportive materials to facilitate production. i.e spares and consumables. Inventory is an ideal stock of physical goods that contain economic value and are held in various forms by an organization in its custody awaiting packing, processing, transformation, use or sale in a future point of sale. The five commonly recognized forms are: i. Raw materials, purchased parts and packaging, ii, Work-in-process, iii. Finished goods, iv. MRO items and v. resale items. Inventories have been described as the life line of any manufacturing organization. Therefore, managing inventory is very important. Inventory refers the overseeing and controlling of the ordering, storage and use of components that a company will use in the production of the items as well as finished goods for sale. (Fraser Johnson & Anna Flynn, 2019). The key benefit of inventory management is to balance the demand and supply. The demand and supply are managed through inventory management. But the real challenges for materials management are: The decisions of how much to acquire and when follow clarification of what is required. The natural response is to say, "Buy as much as you need when you need it (Fraser Johnson & Anna Flynn, 2019). The need of inventory are: i. To gain economies in purchasing beyond current requirement, ii. To maintain service stock whole replacement stock are in transit and iii. To protect against variations in demand (S.C. Sharma, 1999).

1.1. Company Profile

The company is engaged in the manufacture and sale of automotive connectors, moulds, and tools for automotive connectors, and in design and engineering services. This company is a subsidiary of parent companies located in France and USA, The Company has major technical centres, manufacturing sites and customer support facilities in 30 countries. The global market for connectors is around USD 35 billion. The company procures 96% traded parts from foreign sources mostly, from intercompany basis and 4% comes from indigenous sources (within India). The company was facing lot of issues on managing traded parts inventory. Inventory control problems can be approached by several methods including Economic Ordering Quantity (EOQ), Re-Order Level (ROL), Safety Stock (SS), ABC analysis, Vital Essential Desirable (VED), Fast, Slow, Non-Moving (FSN), and Scarce, Desirable, Essential (SDE). VED is most applicable to spare parts inventory management (Mukhopadhyay, 2003). In this study, the author has combined three analyses (3D) to control traded parts inventory, namely ABC analysis, FSN analysis and SDE analysis. ABC analysis is carried out based on annual consumption value of items (high consumption value / low consumption value), FSN analysis is carried out based on the turnover/ consumption rate (fast/ non-moving), and SDE analysis is carried out based on the lead time (long lead time / short lead time). This study is related to inventory management include ABC analysis, FSN analysis & SDE analysis and MUSIC 3D analysis by combining all the three methods. Many manufacturing companies are yet to be used. Some of the companies in automobile sector have implemented. MUSIC 3D approach can produce better results than just using single analysis. The details are highlighted as part of literature review.

2. STATEMENT PROBLEM / RESEARCH GAPS

Most of the companies are using single dimensional methods such as ABC, FSN VED, XYZ and SDE analysis. While using only single dimensional approach, the inventory manager will be missing other dimensions like lead time, criticality,

availability etc . So, it is important to oversee all the aspects critically in inventory management. MUSIC 3D approach can produce better results than just using single analysis. In view of this, there is a scope to conduct research in inventory management.

3. LITERATURE REVIEW

Literature review was conducted by analysing the related papers published in IEEE, Science Direct, ResearchGate, InderScience, and Elsevier Journals. The articles published in this domain from 1999 to 2020(till date) are considered for analysis and the gap was identified. Very few studies were conducted by applying MUSIC-3D approach in warehouse scenario.

Sengottuvelu, C (2020) had applied multi-unit selective inventory control (MUSIC 3D) –Three dimensional analysis by combining three selective inventory control techniques namely ABC, FSN and SDE analysis at an auto components manufacturing unit, Kerala, India. The author has recommended to concentrate on 8 category of items (High Consumption Value / Low Consumption Value, Fast moving / Non-moving, and Long Lead Time / Short Lead Time) (i.e 2x2x2 =8 cells).

Z. Ni'mah and Y.Farida (Z. Ni'mah and Y.Farida, 2019) have used multi-unit spares inventory control (MUSIC 3D) approach to inventory management. In this study, they have used three analysis, namely ABC analysis, SDE analysis and FSN analysis. This study was conducted at PT Fajar Mas Murni, is a trading company in the field of equipment in various sectors.

Muchaendepi. W etal., have (Muchaendepi. W etal., 2019) established that the inventory management systems used by SMEs in the manufacturing sector of Harare are ABC, EOQ, JIT, MRP etc

Nazar Sohail and T.H. Sheikh (Sohail & Sheikh, 2018) have highlighted the need for maintaining inventories in warehouse in order to fulfil customer demand , considering the inventory holding cost.

Sandeep Sharda and Vijay Kumar Gorana (Sandeep Sharda and Vijay Kumar Gorana, 2016) have highlighted the implementation of an integrated selective inventory system named as Multi Unit Selective Inventory Control (MUSIC) by combining three important selective inventory techniques like ABS, FSN and VED.

S.K Biswas etal., (Biswas etal., 2017) have highlighted that the reatial shops generally face two types of inventory related problems which are either stock out or overstock. As a result most of the shops fail to maintain their product availability with lowest possible inventory cost.

R.R. Panigrahi etal., (R.R.Panigrahi etal., 2017) have found that the manufacturing industries are adopting various strategies related to different inventory management practices (IMPs) like ABC analysis, EOQ model, Vendor Managed Inventory (VMI) model, MRP etc.

Sandeep Sharda and Vijay Kumar Gorana (Sandeep Sharda and Vijay Kumar Gorana, 2016) have highlighted the implementation of an integrated selective inventory system named as Multi Unit Selective Inventory Control (MUSIC) by combining three important selective inventory techniques like ABS, FSN and VED.

Darya .P and Arkady. B (Darya .P and Arkady. B, 2015) have established that companies need to have inventories in warehouse in order to fulfil customer demand, but these inventories are having inventory holding costs and this is frozen fund that can be lost.

Sanjeevy, C and Ciby Thomas (Sanjeevy and Ciby Thomas, 2014) have studied the implementation of an improved inventory management and control system of a Chemical processing industry. This study was conducted chor-alkali industry for inventory control of spares. The authors have combined three selective inventory control techniques namely, ABC , VED and SDE (MUSIC 3D). The key performance indicators were also established to give bench operations.

Dinesh Kumar Dhoka and Yokeswara Choudary (Dinesh Kumar Dhoka and Yokeswara Choudary 2013) have studied the challenges involved in XYZ inventory classification. They have classified the items based on demand predictability. Accordingly, the items have uniform demand (X items), varying demand (Y items) and abnormal demand (Z items). The authors have emphasised that the most important drawback of XYZ analysis is categorization of new items.

V.R.Girija and M.S. Bhat (Girija and Bhatt, 2013) have explained that MUSIC-3D approach is helpful to classify all materials into eight categories (2x2x2=8) and to control the materials on all aspects and achieve the cost reduction, in order to facilitate the materials management department as a profit centre.

Chary (S.N. Chary, 2012) has highlighted that a proper ABC analysis will lead to better control over materials and consequent reduction in the costs associated with inventories .

Pradeep Singh (Singh, 2008) has highlighted the effect of the size of inventory and impact on working capital through inventory ratios, working capital ratios etc. The author has mentioned IFFCO and NFL, two fertilizer producing companies by comparing the results.

Sharma M R (Sharma, 1999) emphasises on the application of certain inventory control techniques for optimizing investment in inventories without adversely affecting the smooth functioning of production and sales.

Aravanan focuses (Aravanan, 1999) on the methods and techniques of inventory management and control. On the basis of the analysis, the author has observed that inventory is that component of working capital that is not at all properly managed.

4. OBJECTIVES OF THE STUDY

The main objectives of this research are:

i. To classify the traded parts based on ABC, FSN and SDE analysis.

ii. To apply MUSIC-3D approach to manage traded parts inventory.

5. RESEARCH METHODOLOGY

This paper is a case study of three selective inventory control techniques namely, ABC, FSN & SDE for efficient inventory system of traded parts at Auto Connection Systems Company in Kerala, India. The study also includes 'Multi Unit Selective Inventory Control – Three Dimensional (MUSIC-3D) approach by combining ABC, FSN and SDE analysis. Traded parts include 720 parts, majority of these parts (96%) are received from their intercompany units & few items (4%) are from suppliers from India and stored in their warehouse and then shipped to their customers by road and through air cargo across the country.

5.1. Data Collection: Necessary data for this study were collected from the company's MIS system. Data were collected through their SAP –MIS reports / record files. MS Excel was used in the classification of items. The criterions used by the company for classifying items under ABC, FSN and SDE analysis are applied in the data analysis.

5.2. ABC Analysis: ABC analysis is the most popular one and it classifies into three distinct classes. This technique is based on Pareto principle (80 / 20 rule) and works in dividing items into three categories A, B, and C in order considering their level of significance. 'Class- A' items that are very expensive & require tight control, 'B' items are important & require moderate control, 'C' items are less important as compared to 'A' and 'B'. The main objective of this classification is to draw managers' attention on the critical few (A –items) and not on the trivial many (C-items). Table 1 shows the approximate division of this technique. Annual consumption value of different items for ABC classification technique is calculated as follows:

Annual consumption value = Annual demand x nit price…….. (Equation 1)

Table 1: Rules of ABC Analysis

Classification	Percentage of items	Percentage value of annual usage	Control
Class A Items	About 20%	About 80%	Strict control needed
Class B Items	About 10%	About 15%	Moderate control necessary
Class C Items	About 70%	About 5%	Less control is sufficient

(Source: Sengottuvelu, 2020)

5.3. FSN Analysis: F, S, & N stands for fast moving, slow moving and non-moving items. This form classification identifies the items frequently used, less frequently used and the items which are not used for longer period. Table 2 shows the criteria set by the company in FSN classification.

Table 2: Criteria for FSN Analysis

Classification	Criteria
Fast Moving	Items issued within 30 days.
Slow Moving	Items issued between 31 days and 180 days.
Non-Moving	Items stays for more than 180 days.

(Source: Sengottuvelu, 2020)

FSN analysis helps to identify: i. Inventory Policies, ii. Review policies for different categories of items, iii. Surplus stock, where stock is greater than consumption, and iv. Non-moving items, for determining optimal stock disposal rules rather than inventory provisioning rules, for releasing the idle capital for productive purposes.

5.4. SDE Analysis: In this classification, S-D-E stands for Scarce, Difficult and Easy. It attempts to classify items on the basis of its availability or procurement such as its non-availability, scarcity, lead time, geographical location of the suppliers of the item, reliability etc. Table 3 shows the criteria applied in SDE classification.

Table 3: Criteria for SDE Analysis

Classification	Criteria	Remarks
Scarce Items	Long lead time	Above 21 days
Difficult Items	Medium lead time	Between 11 days and 20 days
Easy Items	Short lead time	Less than 10 days

5.5. MUSIC 3D: MUSIC 3D is an integrated inventory control method to classify items of the company using three dimensional approach. Gopalakrishnan (Gopalakrishnan, 2004) introduced the MUISC-3D model as a 3D matrix focusing on Finance, Operations and criticality. Each of the three dimensions is split in two levels: 'High / Low Consumption Value (HCV / LCV), Long / Short Lead Time (LLT /SLT) and Critical / Non-critical. This classification is quite subjective, but it is easy to implement.

6. RESULTS AND DISCUSSION

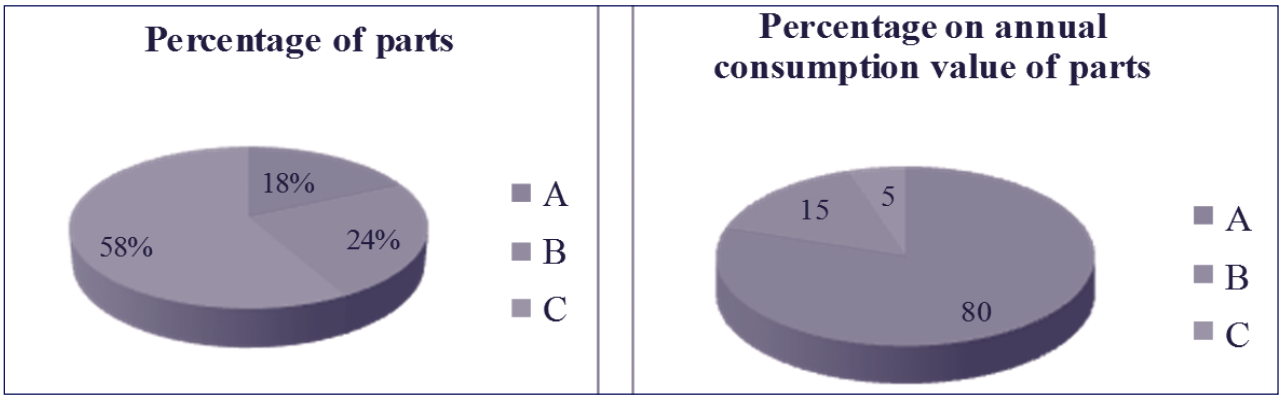
6.1. ABC Analysis Result: Under ABC classification, annual usage / consumption value is calculated through Eq.(1). Items are arranged in the descending order of their annual usage starting with the highest annual usage down to the smallest usage. Percentage annual usage of each item is obtained from annual usage values. Next step is to calculate percentage cumulative usage of 720 traded parts. The number of items is expressed into cumulative item percentages. Items are segregated into A, B and C categories following ABC classification which are shown in Table 5.

Table 4: ABC Analysis

Class	No of parts	Percentage of parts	Value of parts (Rs. In lakh)	Value of items as percentage on total value
A	131	18	2388.21	80
B	171	24	452.99	15
C	418	58	150.06	5
Total	**720**	**100**	**2991.26**	**100**

ABC analysis was done for 720 traded parts based on annual consumption value.131 items (18%) constitutes Rs.2388.21 lakhs (80% of total value) forms class A items, similarly, 171 items (24%) constitutes Rs.452.99 lakhs(15% of total value) forms class B items and the remaining, 418 items constitutes Rs. 150.06 lakhs (5% of total value) forms class C items. So, the warehouse manager should exercise strict control on class 'A' items, moderate control on class 'B' items and little control on class 'C' items.

Figure 1. ABC Analysis Result



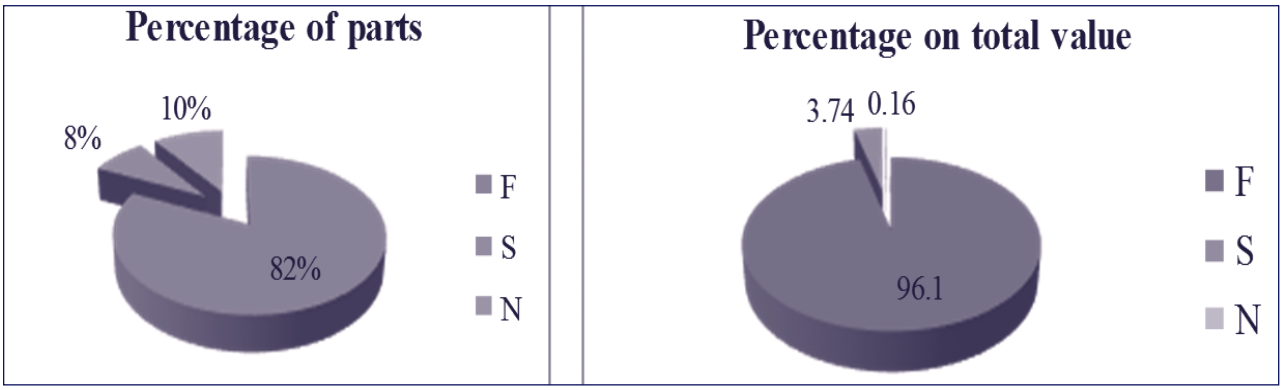
6.2. FSN Analysis Result: The criteria used by the company have been considered for classification of items under FSN analysis. Table 6 shows the FSN analysis of 720 traded parts.

Table 5: Result of FSN Analysis

Category	No. of Items	Percentage of items	Value of items (Rs. In lakhs)	Percentage on total value
F	587	82	2874.48	96.1
S	60	8	111.92	3.74
N	73	10	4.87	0.16
Total	720	100	2991.26	

In FSN analysis, highest priority is given to non-moving items (N), medium priority to slow moving items (S) and least priority to fast moving (F) items. Accordingly, 587 items (82%) which moves fast within 30 days are classified as 'F' items, similarly, 60 items (8%) , which moves between 31 days and 180 days are classified as 'S' items and the remaining 73 items (10%) , which moves beyond 180 days classified as ' N' items. So, the warehouse manager should focus more on 'N' category items only.

Figure 2. FSN Analysis Result



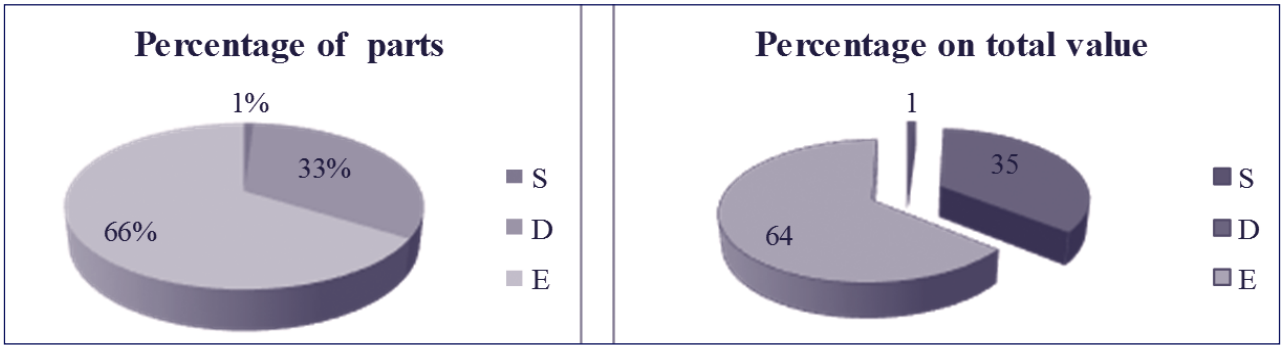
6.3. SDE Analysis Result: The criteria used by the company have been considered for classification of items under SDE analysis. Table 7 shows the SDE analysis of 720 traded parts.

Table 6: Result of SDE Analysis

Category	No. of Items	Percentage	Value of items (Rs. In lakhs)	Percentage on total value
S	9	1	20.37	1
D	236	33	1052.90	35
E	475	66	1917.99	64
Total	720	100	2991.26	100

SDE analysis has been done taking into consideration of lead time for each item. From SDE analysis, it is found that only 9 items takes more than 21 days & classified as ' Scarce ' items, 236 items takes between 10 & 20 days are classified as ' Desirable ' items and the remaining 720 items takes less than 10 days , these items are classified as ' Essential ' items. Based on SDE analysis, the warehouse should focus on 9 scarce items only.

Figure 3. SDE Analysis Results



6.4. MUSIC 3D Analysis: Under MUSIC-3D analysis the annual consumption, frequency of demand and lead time required for procurement of items are considered. The criteria used by the company for FSN and SDE analysis along with ABC classification have been considered. MUSIC-3D analysis is shown in Table 8.

Table 7: MUSIC 3D Analysis

Sl.No	Part No	ABC	FSN	SDE	MUSIC 3D
1	12066317	A	F	D	AFD
2	33152684	A	F	D	AFD
….					
43	54241629	A	F	E	AFE
44	10757690	A	F	E	AFE
……					
124	33288989	A	F	S	AFS

132	8911368	B	F	D	BFD
….					
303	15429045	C	F	D	CFD
….					
719	13950777	C	S	E	CSE
720	AU60100634	C	S	S	CSS

Due to space and number of words restriction, few items are shown in the table, but the analysis conducted for all the 720 traded parts.

6.4.1. Result of MUSIC-3D Analysis: ABC classification, FSN and SDE analysis are combined/ integrated and results are shown in table 9. The analysis includes totally 21 cells (3x3x3=27).

From the analysis, it was found that the category of items such as ANS, ANE, AND, ASS, BNS, BND, BNE, and BSS are zero. Further, it was observed that under item category AFD, AFE, BFD, BFE, CND, CNE, CSE, CFD and CFE cells more number of items reported. Total number of items considered are 720 constituting total value of Rs.2991 lakhs, out of which the above mentioned cells items are 637 items constituting Rs.2984.34 lakhs and the remaining 74 items are non-moving category items constitute only Rs.6.92 lakhs. Further, the warehouse manager should give high priority for A,N,S items, moderate priority for B,S,D items and less priority for C, F, E items.

Table 8: Result of MUSIC-3D Analysis

Sl.No	Category	No. of Items	Value of Items (Rs. In lakhs)	Percentage on Total Value
1	ANS	0	0	0.00
2	AND	0	0	0.00
3	ANE	0	0	0.00
4	ASS	0	0	0.00
5	ASD	3	36.52	1.22
6	ASE	4	29.77	1.00
7	AFS	1	11.32	0.38
8	AFD	42	839.4	28.06
9	AFE	81	1469.13	49.11
10	BNS	0	0	0.00
11	BND	0	0	0.00
12	BNE	0	0	0.00
13	BSS	0	0	0.00
14	BSD	3	9.88	0.33
15	BSE	8	22.04	0.74
16	BFS	1	5.38	0.18
17	BFD	53	124.80	4.17
18	BFE	106	290.90	9.72
19	CNS	1	1.80	0.00
20	CND	27	1.43	0.05
21	CNE	45	3.44	0.12
22	CSS	1	0.25	0.00
23	CSD	8	1.39	0.05
24	CSE	33	12.33	0.41
25	CFS	5	3.67	0.12
26	CFD	100	39.49	1.32
27	CFE	198	88.32	2.95
Total		**720**	**2991.26**	**100.00**

7. CONCLUSION AND SCOPE FOR FURTHER RESEARCH

As stated in this study, the materials manager / warehouse manager has been working with two conflicting objectives of inventory management to ensure maximum items availability while keeping total inventory cost low. In this study, single dimensional selective inventory control techniques namely, ABC, FSN and SDE analysis was conducted individually. After that MUSIC -3D analysis was conducted by combining all the three techniques. Results are analysed individually as well as in combined way. In ABC analysis, Class A items 131 (18% of items) constitutes 80% of the consumption value, whereas, Class B items 171 (24%), constitutes 15% of the value and Class C items 418(58%) constitutes only 5% of total value. In FSN analysis, Category F items 587 (82%), which moves fast within 30 days, Category S items 60 (8%) , which moves between 31 days and 180 days (Slow moving) and Category N items 73 (10%), which moves beyond 180 days (Non-moving). Similarly, in SDE analysis, scarce items 9 only takes more than 21 days (procurement lead time), desirable items 236 takes between 10 and 20 days and essential items 475 takes less than 10 days for procurement. In MUSIC-3D analysis, A, S, N category items are assigned high priority, B, S, D items are assigned moderate priority and C, F, E items are given low priority. Accordingly, only 74 items classified as 'Non-moving' category. So, the warehouse manager should exercise strict control on 74 non-moving items.

This company is not following MUSIC -3D approach for traded parts inventory management. Replenishment and lead time plays an important role in traded parts inventory. So, the company should adopt Re-order level and safety stock concept considering the EOQ. The novelty of this study is that it considers three dimensions such as consumption value, movement / frequency (turnover) and lead time / availability of items. So, MUSIC 3D gives better results than the single dimensional analysis.

So, the company should focus more on these items instead of concentrating on all items. Cost reduction is very much possible to give importance to these items. Other inventory management techniques XYZ analysis may be tried out. Proper demand forecasting plays an important role in inventory management. Forecasting for dependent items (traded part) gives another set of challenges. So, appropriated demand forecasting should be used for demand planning. It is also found that most of the parts (96%) comes from their intercompany basis and few parts (4%) only comes from Indian suppliers. It is suggested that the company should take the advantage of 'Make in India' policy initiative of Indian government by sourcing within India. This improves the resiliency in supply chain management. Considering Covid-19 pandemic and other natural or manmade calamities, sourcing nearby makes sense. Moreover, there is shift from low cost supply to reliable supply.

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AUTHOR

Dr. C. Sengottuvelu, ME., MBA., Ph.D., CPM (ISM-USA) Professor, Operations and Supply Chain Management Area, Dept. of P.G. Management Studies, Acharya Bangalore B-School (Affiliated to Bangalore University), Bengaluru -560 091, India.
Email Id: sengottuvelu138@gmail.com