

Inventory Management of Automotive Industries using ABC Analysis: A Systematic Approach

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Abstract

In any business, it is important to ensure that appropriate amounts of stock are maintained to be able to meet customer demand without delay while keeping holding costs to a minimum. This requires the use of various inventory control techniques. ABC analysis is one such approach for implementing control on the inventory levels of various items by classifying them based on their consumption values. Consumption value indicates the total value of any product consumed over a specified period, for example a year. This approach is based on the Pareto principle, which is widely known as the 80/20 rule. It is observed that categorizing of inventory using ABC analysis provides better control over high-value inventory, which in turn improves its availability and reduces losses and costs. In this study, two major product categories of an automotive component manufacturer (Spark Minda, Ashok Minda Group) are considered for ABC analysis and an optimized inventory categorization pattern is suggested according to the results.

Keywords – ABC analysis; Automotive component manufacturing; Inventory control; Lot sizes; Pareto principle

INTRODUCTION

In supply chain management, inventory is one of the main drivers. Inventory control is a combination of processes or procedures that maximizes the inventory usage of a business. The aim of inventory control is to achieve the greatest possible profit with the lowest investment volume without compromising customer satisfaction. The inventory can be in the form of finished products, stock items, raw materials and many more between supplier and customers throughout the delivery chain. Considering the impact on customers and profits, inventory control should be a key concern for organizations that invest heavily in

inventory, such as retailers and distributors. Inventory control is typically performed on raw materials and finished goods availability, ongoing work items, order point calculations, bottleneck removal, and outsourcing activities.

The reason to have inventories or stocks must be reduced with respect to demand and supply. Having too many stocks under the hand means high maintenance costs and too little lead to an increase in the order cost. Therefore, inventory management must be well planned to reach the lowest level total cost possible. For inventory control systems, various authors have applied various approaches such as ABC inventory control system, three bin system, just in time system, fixed period ordering, fixed period quantity, outsourcing system and many more that are being used by big manufacturers and the retail units. Ramanathan et al. [1] applied a weighted linear optimization model for the classification of inventory items.

Hadi et al. [2] proposed a nonlinear programming model. The results for unit cost and lead time has been determined in their analysis. Yongxia et al. [3] analyzed multi-standard ABC method for inventory management. Further, fuzzy comprehensive evaluation method was also applied for improving the traditional approach. The well-known ABC classification was applied by [4] Karthick et al. in their study to understand and easy to use for inventory management. Mulicriteria inventory ABC classification has been proposed by [5] Balaji and Kumar for an automobile rubber component manufacturing industry. Kiyak et al. [6] classified inventory based on ABC analysis in their work. To deliver the right products rapidly to very specific markets is key to survival, [7] Ravinder and Misra explored ABC analysis for effective inventory management in their work. Material management technique provided helps in efficient material flow, better quality control and reduced material wastages. Mahagaonkar and Kelkar [8] applied the application of ABC in construction management.

Moreover, excel based inventory control system based on ABC has been provided by Goren and Dagdevrien [11]. They provided the ABC-VED matrix for pharmacy in their study. Recently, the number of sold cars and their mileages were studied by Mehdizade et al. [12] using ABC analysis for increasing the total mileages of its relevant cars. The present work focuses on the use of ABC analysis as an inventory control method. Using the ABC approach, one can plan the material requirements of most profit generators goods with higher fluctuation rates. This paper intends to evaluate the feasibility of dividing a range of varied products into 3 broad categories and aims to check the applicability of the results obtained in a case with equal lot sizes.

The application of ABC analysis has been provided for Spark Minda manufacturer group, who employ similar lot sizes for the two product ranges considered in this paper. For cases with varying lot sizes, more advanced methods of analysis can be used, like discussed by [13] Abdolazimi et al. which uses a mathematical model to classify inventory items into more than three categories. The rest of the paper is structured as follows. Section 2 provides assumption and formulation built using product data taken from [14][15] Spark Minda group's website. In section 3, we discuss the steps involved in the methodology. Further, analysis are given in next section 4. Results are provided in section 5. Finally, concluding remarks and suggestions are given in section 6.

PROBLEM FORMULATION

Spark Minda (erstwhile MINDA Group) is one of the leading manufacturers of automotive components for the OEMs. The US \$645 Million Group, comprising of a workforce of more than 17,000 employees is catering to leading Passenger Vehicle, Commercial Vehicle, Motorcycle & Scooter, Off-road Vehicle & Tier 1 manufacturers in India. The company deals in Electronic & Mechanical Security Systems, Die Casting, Key Solutions, Telematics, ITS & IoT, Wiring Harnesses, SRC's, Components, Instrument Clusters, Sensors, Interior Plastics that cater to all major two, three, four-wheeler, commercial, off-road vehicle manufacturers in India & Overseas. To thoroughly understand the impact of applying ABC analysis for inventory control, it has been realized that its application needs to be studied on actual data from the industry. Therefore, maximum retail price (MRP) and inventory data for two products out of Spark Minda's vast product line have been used to perform the analysis.

The data has been retrieved from [14][15] Spark Minda group's website. The formulation of the above data for ABC analysis has been mentioned in the section that follows. Subsequently, results of the analysis have been discussed, along with the suggested type of inventory control. Minda manufactures various types of clutch plates and glow plugs for the different models of two wheelers and four wheelers being produced by the many OEMs. The list of the various types of glow plugs manufactured by the company is given below as Table 1 along with the MRP and package/lot size for each. Table 2 lists the various types of clutch plates manufactured by the company along with the MRP and package/lot size for each.

TABLE 1
DATA FOR GLOW PLUGS

Glow plugs				
Part No.	OEM	Application Model	MRP (Rs.)	Pkg size
GP-3001	Tata	Safari Dicor, Winger	581	20
	Mahindra	XUV 500		
GP-11001	Renault	Logan, Pulse	531	20
	Mahindra	Verito		
GP-10001	Force	Tempo Trax, Traveller	336	20
GP-9001	Chevrolet	Tavera BS-II	531	20
GP-2001	Mahindra	Bolero	450	20
	Piaggio	Ape Euro-I		
	Ford	Ikon 1.8D		
GP-3002	Tata	Sumo, Sierra, Estate	299	20
	Mahindra	Jeep		
	Bajaj	Tempo		
GP-3003KT	Tata	Kit for Indica	1400	20
GP-8001	Ford	Fiesta, Ikon 1.4 lt, Figo	600	20
GP-1001	Maruti	Swift SDE, Ritz DDIS, Dzire DDIS	600	20
	Fiat	Punto, Linea		
	Tata	Vista		
GP-2003	Piaggio	Ape BS (Lambordini)	249	20
	Mahindra	Bolero		
GP-3003	Tata	Indica (Basic, Ev2) Indigo (Basic, CS)	320	20
	Maruti	Zen D, Esteem D		
	Pal	Puegeot		
GP-6001	Toyota	Innova	450	20
GP-6002	Toyota	Qualis Euro-I	450	20
GP-6003	Toyota	Qualis Euro-II	450	20
GP-5001	Hyundai	Accent	460	20
GP-5002	Hyundai	I-20	531	20
GP-7001	Volkswagen	Polo	531	20
GP-7002	Volkswagen	Vento	531	20
GP-9002	General Motors	Beat	531	20

TABLE 2
DATA FOR CLUTCH PLATES

Clutch plates			
Part No.	Description	MRP	Pkg size
CP-1001	Hero Motocorp	158	50
CP-1002		215	50
CP-1003		202	50
CP-1004		208	50
CP-1005		208	50
CP-2001	Bajaj Auto	157	50
CP-2002		194	50
CP-2003		160	50
CP-2004		202	50
CP-2005		247	50
CP-2006		230	50
CP-2007		258	50
CP-2008		314	50
CP-2009		215	50
CP-2010		202	50
CP-2011		202	50
CP-7001	Honda Motorcycles and Scooters	195	50
CP-7002		197	50
CP-3001	TVS Motors	56	50
CP-3002		194	50
CP-3003		194	50
CP-3004		195	50
CP-4001	Yamaha India	260	50
CP-4002		249	50
CP-9001	Suzuki Motorcycles India	170	50

METHODOLOGY

ABC analysis is a categorization method for inventory which comprises of dividing items into three categories A, B and C: where A is the most valuable items, B is the intermediates items and C is the least valuable ones. This method draws its basic principle from the Pareto principle, which states that 80% of the overall consumption value is based on only 20% of total items. Pareto analysis is a method to classify articles, events or activities according to their relative importance. In inventory management, it is often used for classifying inventory items into groups based on the total annual expense or total storage cost of each item. Organizations can focus more attention on high value / important objects. Pareto's analysis is used to arrive at this

definition of priorities. Phrasing, otherwise, demand is not evenly distributed between items: top sellers vastly outperform the rest. Similarly, ABC analysis aims to draw managers' attention on the critical few (A-items) and not on the trivial many (C-items). It states that, when reviewing inventory, a company should rate items from A to C, basing its ratings on the following rules:

- A category items are the products which annual consumption value is the highest. The major chunk, i.e., 70-80% of the annual consumption value of the company generally accounts for only 10-20% of total inventory items.
- B category items are the interclass items, with a medium consumption value. This 15-25% of consumption value per year generally accounts for 30% of total inventory items.
- C category items are the items with the lowest consumption value. The lower 5% of the consumption value per year generally accounts for 50% of total inventory items.

Such a division is feasible in cases with equal lot sizes, since it is easy for a manager to work with a small number of categories, without losing efficiency of operation. More advanced methods of categorization may be used in situations with high variety in item values and lot sizes.

ANALYSIS

The annual consumption value can be calculated using the formula: (Annual demand) x (item cost per unit). Through this categorization, the supply manager can identify inventory hot spots, and separate them from the rest of the items, especially those that are numerous but not that profitable. After the categorization, the manager can now separately control the inventory of each category.

- A-items require tight inventory control, better secured storage areas and even better sales forecasts. Reorders need to be frequent- weekly or even daily. Avoiding stock-outs on A-items should be the top priority.
- B-items have an intermediate status between A and C. An important aspect of inventory control of class B is the monitoring of potential evolution toward class A or, in the contrary, toward class C.
- Reorder on C-items is made less frequently. This approach may lead to a stock-out situation after every purchase which can be an acceptable situation, as the C-items pose both lower demand and higher risk of excessive inventory costs.

Fig. 1 depicts the steps for carrying out ABC analysis as given below:

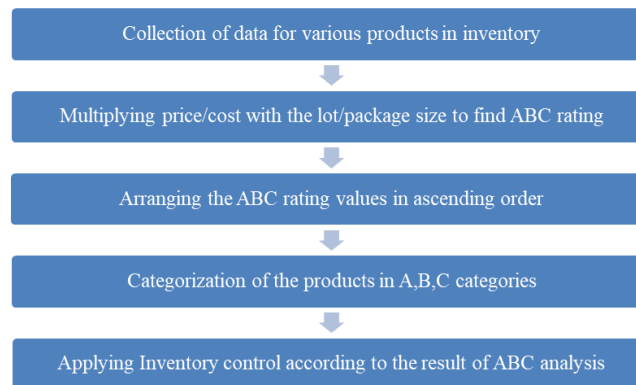


FIGURE 1
STEPS OF ABC ANALYSIS

Following the steps mentioned above, after collecting the data, the ABC rating for each was part/product was then calculated by multiplying the MRP with the package/lot size which is as shown in Table 3. MRP and lot sizes are taken as the sensitive parameters since MRP of the product signifies its sales value and lot sizes indicate the portion of inventory that item will occupy, or the order quantity.

TABLE 3
COMPLETE DATA ALONG WITH ABC RATING

Part No.	OEM	Application Model	MRP (Rs.)	Pkg size	ABC Rating
GP-3001	Tata Mahindra	Safari Dicor, Winger XUV 500	581	20	11620
GP-11001	Renault Mahindra	Logan, Pulse Verito	531	20	10620
GP-10001	Force	Tempo Trax, Traveller	336	20	6720
GP-9001	Chevrolet	Tavera BS-II	531	20	10620
GP-2001	Mahindra Piaggio Ford	Bolero Ape Euro-I Ikon 1.8D	450	20	9000
GP-3002	Tata Mahindra Bajaj	Sumo, Sierra, Estate Jeep Tempo	299	20	5980
GP-3003KT	Tata	Kit for Indica	1400	20	28000
GP-8001	Ford	Fiesta, Ikon 1.4 lt, Figo	600	20	12000
GP-1001	Maruti Fiat Tata	Swift SDE, Ritz DDIS, Dzire DDIS Punto, Linea, Vista	600	20	12000
GP-2003	Piaggio Mahindra	Ape BS (Lambordini) Bolero	249	20	4980
GP-3003	Tata Maruti Pal	Indica (Basic, Ev2) Indigo (Basic, CS) Zen D, Esteem D, Puegeot	320	20	6400
GP-6001	Toyota	Innova	450	20	9000
GP-6002	Toyota	Qualis Euro-I	450	20	9000
GP-6003	Toyota	Qualis Euro-II	450	20	9000
GP-5001	Hyundai	Accent	460	20	9200
GP-5002	Hyundai	I-20	531	20	10620
GP-7001	Volkswagen	Polo	531	20	10620
GP-7002	Volkswagen	Vento	531	20	10620
GP-9002	General Motors	Beat	531	20	10620

Results

In this section, we provide various results to calculate most financial value using ABC analysis. Based on the method proposed, A, B and C categories are given in table 3. The items are categorized based on criticality (ABC rating) which we arrived at by multiplying the MRP (Sales value) with the lot sizes (Order quantity) for the respective products. Also, we visualize the inventory distribution in Figure 2 and ABC analysis rating in Figure 3 for various categories, respectively.

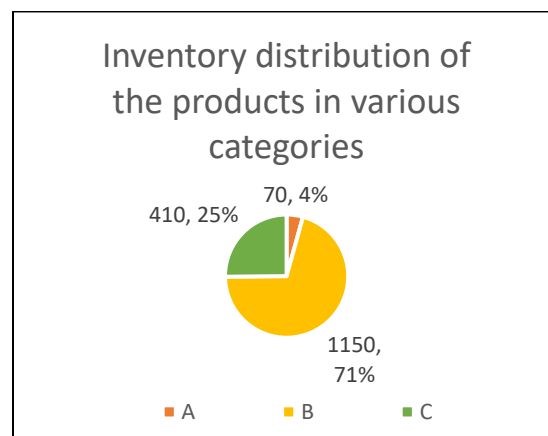


FIGURE 2
INVENTORY DISTRIBUTION OF PRODUCTS IN VARIOUS CATEGORIES

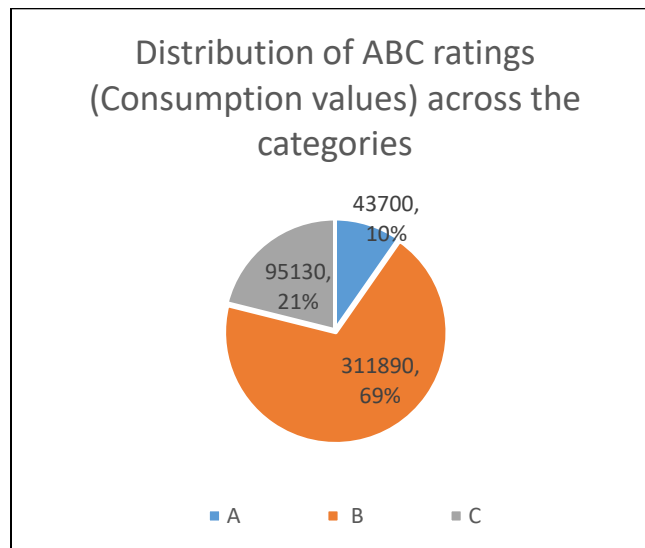


FIGURE 3
DISTRIBUTION OF ABC ANALYSIS FOR VARIOUS CATEGORIES

The products were then arranged in order of decreasing value of ABC rating, and were categorized into A, B and C categories according to the percentage of revenue that each product brings to the company, as shown in the below Table 4. Here, category A is shown in green color, category B in yellow, and category C is shown in red.

It is evident from table 4 that the most percentage of revenue is brought to the company by the glow plug GP-3003 KT (~6.21%) and the clutch plate CP-2008 (~3.48%), whose total revenue amounts to ~9.69% or around 10%. As a result, both have been put into the A category, and thus would require tight inventory control with frequent reorders. The products whose revenue percentage is between 2-3% have been put in the B category. These products need to be monitored closely and efforts must be made to upgrade these products to the A category. In the C category, those products have been included which only have 0-2% contribution in the total revenue. Reorders on these products would be the least frequent, and lenient inventory control can be exercised.

This was a case of products with equal lot sizes, and therefore we can see that the results of the ABC analysis have been dependent on the MRP of the product. If we correlate the MRP of the product to the demand, we can safely say that the analysis carried out is perfectly suitable to the scenario discussed and Spark Minda group should follow this method of inventory categorization. However, this may not be the case for other manufactures both in automotive manufacturing industries and other industries, as lot sizes may vary quite a lot for different products. This is beyond the scope of our current study since it aims to only evaluate the feasibility of the ABC analysis method, particularly three-way categorization. However, for such cases, a method used by [13] Abdolazimi et al. can be suggested, which uses a mathematical model to classify inventory items, considering significant profit and cost reduction indices with an objective function to maximize the net profit of items in stock.

TABLE 4
FINAL CATEGORIZATION

Part No.	OEM	MRP (Rs.)	Pkg size	ABC Rating	%Revenue	Category
GP-3003KT	Tata	1400	20	28000	6.21228257	A
CP-2008	Bajaj Auto	314	50	15700	3.483315584	A
CP-4001	Yamaha India	260	50	13000	2.88427405	B
CP-2007	Bajaj Auto	258	50	12900	2.862087327	B
CP-4002	Yamaha India	249	50	12450	2.762247071	B
CP-2005	Bajaj Auto	247	50	12350	2.740060348	B
GP-8001	Ford	600	20	12000	2.662406816	B
GP-1001	Maruti Fiat Tata	600	20	12000	2.662406816	B
GP-3001	Tata Mahindra	581	20	11620	2.578097267	B
CP-2006	Bajaj Auto	230	50	11500	2.551473198	B
CP-1002	Hero Motocorp	215	50	10750	2.385072772	B
CP-2009	Bajaj Auto	215	50	10750	2.385072772	B
GP-11001	Renault Mahindra	531	20	10620	2.356230032	B
GP-9001	Chevrolet	531	20	10620	2.356230032	B
GP-5002	Hyundai	531	20	10620	2.356230032	B
GP-7001	Volkswagen	531	20	10620	2.356230032	B
GP-7002	Volkswagen	531	20	10620	2.356230032	B
GP-9002	General Motors	531	20	10620	2.356230032	B
CP-1004	Hero Motocorp	208	50	10400	2.30741924	B
CP-1005	Hero Motocorp	208	50	10400	2.30741924	B
CP-1003	Hero Motocorp	202	50	10100	2.24085907	B
CP-2004	Bajaj Auto	202	50	10100	2.24085907	B
CP-2010	Bajaj Auto	202	50	10100	2.24085907	B
CP-2011	Bajaj Auto	202	50	10100	2.24085907	B
CP-7002	Honda Motorecycl	197	50	9850	2.185392261	B
CP-7001	Honda Motorecycl	195	50	9750	2.163205538	B
CP-3004	TVS Motors	195	50	9750	2.163205538	B
CP-2002	Bajaj Auto	194	50	9700	2.152112176	B
CP-3002	TVS Motors	194	50	9700	2.152112176	B
CP-3003	TVS Motors	194	50	9700	2.152112176	B
GP-5001	Hyundai	460	20	9200	2.041178559	B
GP-2001	Mahindra Piaggio Ford	450	20	9000	1.996805112	C
GP-6001	Toyota	450	20	9000	1.996805112	C
GP-6002	Toyota	450	20	9000	1.996805112	C
GP-6003	Toyota	450	20	9000	1.996805112	C
CP-9001	Suzuki Motorecycl	170	50	8500	1.885871494	C
CP-2003	Bajaj Auto	160	50	8000	1.774937877	C
CP-1001	Hero Motocorp	158	50	7900	1.752751154	C
CP-2001	Bajaj Auto	157	50	7850	1.741657792	C
GP-10001	Force	336	20	6720	1.490947817	C
GP-3003	Tata Maruti Pal	320	20	6400	1.419950302	C
GP-3002	Tata Mahindra Bajaj	299	20	5980	1.326766063	C
GP-2003	Piaggio Mahindra	249	20	4980	1.104898829	C
CP-3001	TVS Motors	56	50	2800	0.621228257	C
Total Revenue				450720	100%	

CONCLUSION

In the current manufacturing environment, an organization needs to maintain the balance between critical stock- outs and minimizing inventory costs. From the above study we can conclude that ABC analysis can effectively be used for managing

the sales or production inventory effectively not only for raw material but also for finished goods. It can help in facilitating selective control and thereby can save valuable time of company executives. However, it can be observed from the results obtained that only a small no. of items constitutes the A category for this case, compared to the large no. of items in the B & C category. This can be attributed to the lesser degree of variation in the data for the MRP and pkg. size of the products. Therefore, it can be concluded that ABC analysis might not prove very effective for cases where the pkg. size or MRP is spread out in a larger range of values. It was concluded that ABC analysis can effectively be used for managing the sales or production inventory effectively particularly in cases with less or no variation in lot sizes Further study can be carried out for such cases using multi-criteria ABC analysis, which considers many factors like lead time, item criticality, durability, scarcity etc. other than the cost/MRP or lot/pkg. size.

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