ANALYSIS OF VARIABILITY IN INVENTORY CONSUMPTION AND ITS UTILIZATION IN INDUSTRY

BESTA Petr[1], NÉTEK Václav[2], KUBICA Stanislav[1], PROSICKÝ Petr[2]

[1]*VSB - Technical University of Ostrava, Ostrava, Czech Republic, EU, petr.besta@vsb.cz*
[2]*Business School Ostrava (VSP), Ostrava, Czech Republic, EU*

Abstract

Inventories are a factor that significantly affects competitiveness of any manufacturing enterprise. Manufacturing companies should protect inventories against unexpected fluctuations in their consumption and deliveries and thus promote the continuous nature of the production process. Inventories, however, are also naturally associated with the costs required for their maintenance. It is therefore crucial to precisely evaluate the previous consumption and properly adjust the amount of safety supplies. A very useful tool for statistical analysis of data seems to be the method of measuring the variability of consumption. This method allows us to assess the intensity of fluctuations in consumption very easily. The respective conclusions can then be used for estimating the future consumption as well as for setting the amounts of safety inventory levels. The paper analyzes the use of this tool in the field of inventory management in industrial plants.

Keywords: Cost, inventory, profit, storage

1. INTRODUCTION

Inventory management means an effective manipulation and effective management of inventory, the utilization of all reserves that exist in this area, and respecting all the factors that affect the efficiency of inventory management Stocks significantly affect costs [1].

The existence of inventory at the moment when there is no use of it and when there is no demand for it causes unnecessary spending. Lack of inventory at the moment when it is necessary to meet a customer's order leads to a loss of sales and, consequently, to a loss of customers and goodwill of the company. In the sphere of continuous production processes, it is naturally necessary to maintain adequate inventory level because of the need of its technological treatment. Supplies not only attach considerable capital, but also reduce the profits of an enterprise [2, 3].

Companies often get into difficult-to-solve situations in the area of planning, management and procurement of material resources. On one hand, there are hard-to-estimate impulses entering the production organization in the form of market incentives, on the other hand, every production entity tries to plan all production processes as realistically as possible. It is therefore a conflict between two systems that are completely different [4]. The consequences of this situation are problems arising when setting up the optimal inventory levels. Generally speaking, the inventory as a whole, will always mean certain amount of complications for the company associated with its storage, maintenance, monitoring of quality, but especially with capital tied in inventories [5].

2. METHODS FOR INVENTORY OPTIMIZATION

The global financial crisis has forced many companies to address the efficiency of all business processes. A key question crucial for the prosperity of the company is the effective inventory management. Many medium and small companies still use rather tentative and intuitive approach to control the levels of their inventory. In the area of inventory classification, a variety of exact methods can be applied. The fundamental methods include Pareto analysis and XYZ analysis which is used for the assessment of consumption variability. The basic inventory classification methods include ABC analysis and XYZ analysis. The principle of the two methods consists in the classification of the monitored phenomena into three (A, B, C) or more groups whereas each of the groups should be given different attention.

The ABC analysis results from the Pareto Law. Its principle is based on the assumption that approximately 80 % of the effects are induced only by 20 % of all possible causes. As an example, it is possible to state that the majority of poor quality products are produced in a limited number of manufacturing operations, or that most of the sales relate only to a narrow range of products. ABC analysis is a versatile tool for solving logistics problems. It is a popular and frequently used method in logistics practice. The method is very undemanding, time-wise as well as computationally, and the results are clear and transparent. [6, 7]

The procedure in conducting the ABC analysis:

- Determine precisely the value of annual consumption for each material item.
- Determine the total inventory value for all items.
- Determine the percentage of each item.
- Sort items in descending order from most to less substantively significant.
- Determine cumulative totals.
- Classify items into A, B, C groups or other groups - groups A, B and C should contain items contributing to the overall consumption approximately by 80 %, 15 % and 5 %, respectively. Items in each group should be simultaneously volume-similar. It is not appropriate that one group contains items varying in volume by more than 10%.
- Develop a graphic form of the analysis (Lorenz curve).

The XYZ analysis is also often called a variability analysis. Unlike the ABC analysis, this method evaluates the consumption regularity. It is logical that the approach selected for materials with regular consumption will differ from that for supplies used just sporadically. The items are again classified into three or more groups. Group X contains items with highly regular consumption which does not show any significant fluctuations. Group Y includes items that show strong seasonal fluctuations or trends. Group Z contains items whose consumption is maximally irregular and difficult to predict. The items are assigned to groups X, Y, Z according to the value of variation coefficient [8]:

- X - Variation coefficient up to 50%.
- Y - Variation coefficient of 50 - 90%.
- Z - Variation coefficient over 90%.

The variation coefficient, in essence, determines the actual disparity of the statistical set. It is calculated as the ratio of standard deviation and simple arithmetic average, multiplied by one hundred (the result as a percentage). The procedure in conducting the XYZ analysis:

Identify the values of consumption for each item over the given period:

- Calculate the simple arithmetic average.
- Calculate the standard deviation.
- Calculate the variation coefficient.
- Classify the items into individual groups.

In the logistics practice, it often happens that both methods (ABC - XYZ) are used simultaneously. The items are then classified into groups AX, BY, AY, etc. This classification then gives an overview about the volume structure as well as consumption regularity of individual items.

3. ANALYSIS OF VARIABILITY IN THE INVENTORY CONSUMPTION

As part of the research, an analysis of variability was conducted in the observed production company. The analysis focused on items that were identified as typical. They are inventory items whose variability of consumption corresponds to a wide range of different inventory items. These inventory items can then be generally summarized into five basic groups A - E. **Table 1** shows individual inventory items and data on their consumption for seven months. Data on the total consumption and the average for each month were determined with regard to each inventory item. Standard deviation values were calculated at the same time. Subsequently, the average and standard deviation values were used to calculate the values of variation coefficient. According to variation coefficient values, the items were classified into different variability groups. Table 1 presents the values of all parameters as well as the final variability grouping.

Table 1 Data on inventory consumption

Inventory	Month							Indicator			
	Jan (kg)	Feb (kg)	Mar (kg)	Apr (kg)	May (kg)	June (kg)	July (kg)	Average	S_x	V_x	XYZ
A	9800	8600	9200	8880	9760	9450	9360	9293	408	4.4	X
B	1450	1480	9850	4050	780	1471	150	2747	3109	113.2	Z
C	2580	6900	8500	6900	1140	1980	3200	4457	2687	60.3	Y
D	90	102	500	6900	4080	170	390	1747	2488	142.4	Z
E	4350	4480	4600	4219	4690	4989	4650	4568	232	5.1	X

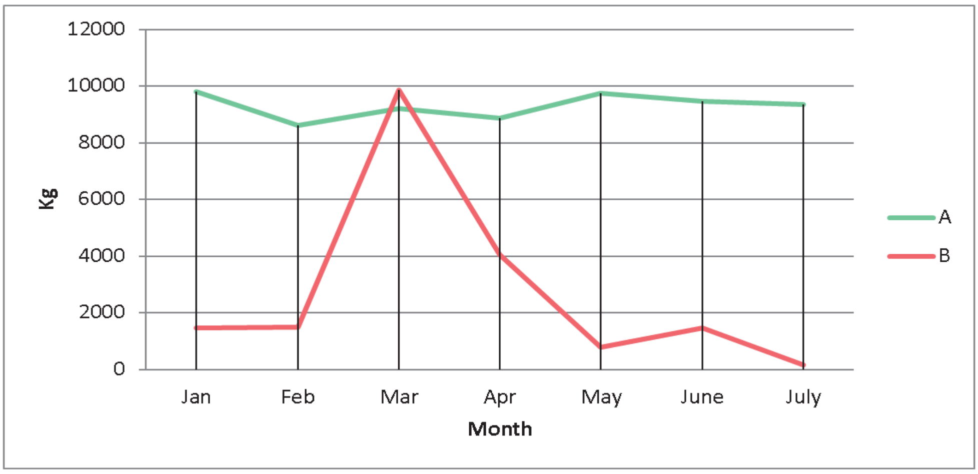

Fig. 1 Development of consumption for inventory items A, B

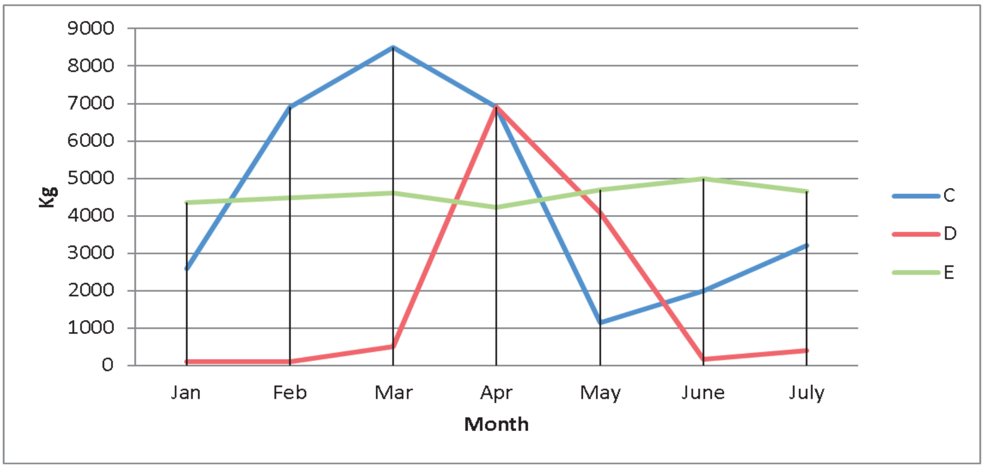

Fig. 2 Development of consumption for inventory items C, D, E

Figures 1, 2 show graphically the course of inventory consumption for all the monitored items. According to the variability analysis, the analyzed inventory items were included into all three basic groups. Inventory items A, E were included in the group X. In these items, the values of variation coefficient were 4.4 % and 5.1 %. This inventory therefore has a minimal variability. Generally, the future consumption of these items can be predicted very easily. At the same time, when setting the safety stock levels, it is possible to use the average consumption value which highly correlates with consumption in each month. In case of items with very short delivery time, the safety stock levels can also be adjusted to minimum amounts. Excellent prediction of future consumption should imply a minimum of problems while optimizing the inventory. A significantly higher degree of variability belongs to the inventory item C. Variation coefficient for this inventory item is 60.3%. This indicates a limited predictability of future consumption. When managing the inventory of these items, it is necessary to maintain larger safety stock levels and also consider the respective delivery times. For delivery times of several months, it is necessary to create an adequate amount of safety stock. When determining safety stock levels for these inventory items, the use of standard deviation value should be preferred over the arithmetic mean. Inventory items B, D were classified into the variability group Z (variability of 113.2 %, 142.4 %). This group includes items with extreme consumption variability and very limited predictability. Due to strong fluctuations in consumption, the estimate of future consumption is particularly problematic. Regarding these inventory items, it is therefore very useful to evaluate not only delivery times but also the risks arising from the lack of supplies. This basically means a potential damage for the organization in the event of inventory shortage. In the case of such high fluctuations in consumption, an ideal solution is to use consignment stocks. However, this depends on the current supplier as well as potential future inventory consumption. For all categories of variability, it is to be noted that the conclusions drawn will be valid if the future consumption corresponds to the analyzed data. This is currently quite complicated due to dynamic changes in the market environment.

4. CONCLUSION

Inventory management can significantly affect competitiveness of companies. The analysis of trends in inventory consumption can provide vital information to optimize the adjusted safety inventory levels. High safety inventories will contribute to satisfying customer needs in a more operational way and increase the smoothness of the manufacturing process. Nevertheless, these supplies will also significantly increase costs. The most crucial item associated with inventories then can be the costs of their maintenance and warehousing. These can already be quite easily quantified per the selected unit (pc, ton, kg). The conducted analysis clearly shows the importance of monitoring the variability in inventory consumption. Monitoring of inventories according to their quantity but also the nature of consumption in a given period of time can provide essential information for purchase planning and warehouse management. When setting the safety levels of inventories, it is necessary to consider not only the specific amount of given items, variability of their consumption, delivery time and risks arising from potential shortages but also any seasonal nature. Determining safety levels based on an analysis of data on past consumption is particularly suitable where we can expect that the future consumption will have a very similar character. In this case, it is possible to determine the planned value of safety stock with a relatively high accuracy. However, if the future consumption is significantly different, the amounts of safety levels adjusted in this manner will be substantially inaccurate. The applied method of measuring the variability of consumption of inventories also measures the magnitude of fluctuations in consumption within the given period. Therefore, we can very easily observe recurring fluctuations or long-term trends. This may be of great importance in the inventory management. Utilization of the applied methodology is then very versatile and it is possible to use it under arbitrary manufacturing as well as non-manufacturing conditions. A big advantage is its algorithmic modesty. Manufacturing companies will constantly try to look for reserves in their processes in order to be able to face the current highly competitive environment. With regard to the above circumstances, the use of statistical tools and methods in the area of inventory management seems to be very appropriate.

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