

**THE POSSIBILITIES OF THE STRUCTURE AND VARIABILITY EVALUATION OF INVENTORY CONSUMPTION**

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monika.bumbova@vspp.cz**Keywords:** inventories, logistics, variability, costs

**Abstract:** Inventory can be evaluated from the point of view of a number of aspects. Production and trade organizations nowadays are under great pressure from their competitors and face high expectations from their customers. That is why the cost cutting in all areas can provide a significant competitive advantage. Inventory and its management and administration can therefore represent a source of substantial potential savings. Large inventory volume can significantly increase the costs, but its shortage influences the course of the manufacturing process and, ultimately, the customer satisfaction. It is therefore necessary to continuously optimize the inventory management system in the enterprise. The conducted research also involved an analysis of the structure and variability of the inventory consumption in a business organization dealing with the sale and storage of metallurgical materials. The objective of this article is to evaluate the possibility of the application of the tools used to analyze the structure and variability of inventories in the industrial and commercial practice.

**1 Introduction**

Inventory management involves an effective handling and management of inventories, the use of all the reserves that exist in this field, and respecting all the factors that affect the efficiency of inventory management [1, 2]. The existence of inventories at the moment when they are not used and there is no demand for them means unnecessary spending. The lack of inventories at the moment, when it is necessary to satisfy the customer's order, results in lost sales, followed by the loss of the customers and goodwill. Of course, it is necessary to maintain an adequate inventory level in the area of continuous manufacturing processes, given the need to carry out their technological adjustments. The agglomeration processes in metallurgical production, through which the ore concentrate passes prior to entering the blast furnace process, can serve as an example. It is therefore essential to maintain an adequate inventory level within the scope of these manufacturing processes, because their adjustment is very time consuming.

Generally speaking, the aim of inventory management is keeping the inventory in such a level and in such a composition to secure the rhythmical and uninterrupted production, as well as the promptness and completeness of the deliveries to customers, while keeping the total related costs as low as possible. Inventory management includes, in addition to the very existence of inventories and their development, other elements as well, namely the

care about the structure of inventories, their storage and use, the efficient inventory management and the utilization of all available reserves - these should be the focal points of interest and attention of every company [3, 4]. Effective inventory management can fundamentally influence the economic results of the manufacturing enterprises. Inventory management consists of a number of activities, which are based on forecasting, analysing, planning, and operational activities and control operations within the individual inventory groups and within the inventory as a whole. The right inventory management is one of the factors deciding about the fulfilment of company objectives with the optimal allocation of costs.

**2 Inventories and their impact on cost development**

The costs associated with keeping inventory can be looked upon in various ways. One of the alternatives is the classification of inventory according to the model of the economic order quantity. This model divides the costs associated with inventory into two groups: the cost of maintaining inventory and the ordering costs. The costs of maintaining inventory include all the items that are related to the physical possession of the inventory. These are, above all, the following costs:

- the costs of capital frozen in inventory,

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- the costs of maintaining a warehouse,
- the costs of inventory and warehouse space insurance,
- the costs of risk [5].

The costs of capital frozen in the inventory can be defined as the potential profit the funds intended for the purchase of inventory could have brought if they had been invested in a different way [6]. You can usually use the current standard interest rate. The costs of maintaining a warehouse include all the costs associated with the operation of the warehouse and the inventory records. The cost of inventory insurance can be defined as the amount spent on the inventory insurance for a certain period of time. The costs of risk represent a potential risk related to the fact the inventories might not be saleable or usable in the future, mainly due to physical or moral wear. The second group of the costs associated with inventory management are represented by the costs of ordering [7]. These costs include especially the expenses related to the monitoring of inventory usage, processing, issuance and delivery of the order, but also the expenses associated with the transport, control and storage. An efficient inventory management system is optimal if it is possible to calculate these costs for a specific unit (piece tonne, packaging, and pallet). Given the wide nature of the monitored costs, however, the determination of the unit costs does not tend to be easy and objective. The process of the definition of all costs always requires the application of certain simplification in order to make the solution easier.

### 3 Planning future inventory consumption

A forecast of the future development is always an essential prerequisite for quality planning and management. The link between the forecast and direct inventory management is most evident in the area of the buffer stock level setting. The accuracy of the future state forecast is directly proportional to the buffer stock level reduction. The more accurately we can predict the future state as far as the demand dispersion from the mean value is concerned, the lower the buffer stock. Steep seasonal fluctuations, new trends, and turbulent external economic environment - these are the factors that make forecasts increasingly difficult. Sometimes, they even lead to a false feeling that forecasts are impossible, and they are not worth dealing with. This is not true. It only sometimes happens that certain exact forecasting methods are more difficult to apply in practice. However, in situations where these methods cannot be used, they must be replaced with intuitive ones [8, 9]. If you use the exact methods, you must also realize that each planning will, in practice, deal with a certain error. That is why it can be said that the exact methods can use their name mainly due to the unique process of their implementation. The standard exact methods are based on the principle of extrapolation

of the course of the values from previous periods. This principle is based on placing a curve or a straight line extended into the future through the curve of the course of previous values. The most commonly used exact methods include, for example: the method of moving averages, the weighted moving averages, the regression analysis, the correlation analysis and other methods. The methods of moving averages are based on the principle of placing a straight line through the present development, the direction of which is determined by the potential estimate. The regression and correlation analysis works with mathematically described curves used to search for further development. Large multinational companies, however, also often use the intuitive planning methods. This principle is based primarily on experience, intuition, knowledge of the environment, ability of analytical thinking and the creativity of workers. These principles can be used wherever the exact methods fail - i.e. especially in situations where the historical data necessary for the exact analysis are missing or are highly imprecise and biased [10]. In ideal case, the intuitive forecasts are verified by means of the exact methods. In the event that an intuitive estimate meets the calculated values with a certain corresponding tolerance, the degree of forecast accuracy is higher. However, the global economic crisis has shown that the market environment involves situations that cannot be predicted by any methods. It is important for the companies to be able to plan and optimally set their buffer stock values in shorter periods of time. Excessive inventory level can significantly increase the costs, while inventory shortage threatens the continuous course of the production process.

### 4 Inventory structure analysis

Inventory can be assessed according to many different factors. The logistics process optimization often makes it necessary to consider various criteria. The basic options include the use of Pareto analysis as a tool for inventory structure assessment. Pareto analysis is also known as the ABC method, according to the number and names of the groups into which the individual inventory items are classified. Inventories are mostly classified into three groups according to their size (significance). The basic principle of the Pareto analysis is the assumption that 20% of causes are responsible for 80% of consequences. In the area of inventory, we try to identify a narrow group of inventory items that are the key ones in terms of the total volume. In industrial practice, the differences among the individual inventory items are often very little, which is why it is possible to classify inventories into more than three groups. When the Pareto analysis is applied, we can define groups ABCDEF etc. The development of the Pareto analysis preparation can be simply described in the following points:

- Accurate determination of the value of all inventory items and their total sum.

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- Determination of the percentage share of each item on the total.
- Ranking of the items according to the percentage content.
- Determination of the cumulative totals.
- Classification of the items into groups ABC or other. Group A should contain the items contributing to the total consumption in the amount of about 80%, Group B - 15% and C - 5%.

The second crucial factor in inventory management is the variability of consumption. We can use a wide range of statistical indicators to determine it. The most widespread ones include the variation coefficient used by the XYZ classification method. Unlike the ABC analysis, this method evaluates the regularity of consumption. It is logical that a different approach will be selected for materials whose consumption is regular and for inventories that are used only sporadically. The items are again classified into three or more groups. Group X contains the items with highly regular consumption, which do not have any significant fluctuations in their consumption. Group Y contains the items that show strong seasonal variations (trends). Group Z includes the items whose consumption is most irregular and the consumption forecast possibilities are limited. The items are classified into the XYZ groups according to their variation coefficient values (Formula no. 1): X – variation coefficient of up to 50%; Y – variation coefficient of 50-90%; Z - variation coefficient exceeding 90%. The variation coefficient essentially determines the actual disparity of the statistical set. Higher dispersion and remoteness of the individual values from the mean rate position will mean a higher degree of variability in consumption. The variation coefficient is calculated as the quotient of standard deviation and the simple arithmetic average, and this figure is subsequently multiplied by the constant of one hundred (the result is a percentage value).

$$V_x = \frac{S_x}{x} \times 100 \quad (1)$$

The evaluation of the intensity of inventory consumption variability allows us to identify the trends and irregularities in consumption. The dynamic changes, which are typical for current markets, mean more and more intensive occurrence of irregularities for companies. The companies must continually quantify their intensity in order to be prepared for these fundamental changes. The processing of XYZ analysis can be generally classified into the following points:

- Elaboration of the record of inventory consumption during a given period.
- Calculation of the average - simple arithmetic average.
- Calculation of the standard deviation.
- Calculation of the coefficient of variation.

- Classification of the items into different groups.

The area of inventory management in industrial companies often witnesses a situation where these two methods (Pareto analysis and variability analysis) are used simultaneously. The items are analyzed according to their volume and variability of consumption and are classified into complex groups: AX, BY, CZ.

### 5 Experimental part

An analysis of the structure and variability of inventory consumption in companies engaged in the sale and distribution of metallurgical materials was conducted as part of the research. The monitored firm is an important local company. The inventory analysis took advantage of the Pareto analysis and the XYZ method allowing for the evaluation of the variability in consumption. The assessment included the most significant traded commodities. Table 1 shows the key inventory items together with their specific volumes. At the same time, the table also shows the percentage share on the total inventory volume. In the next step, the individual metallurgical products were sorted from the most important ones in terms of their volume to the less important items. A cumulative total was determined for these items sorted in descending order, and the inventories were classified into groups ABC. The results are shown in Table 2. The crucial group A includes strips and slabs. These inventory items were the most significant in terms of their volume, but, at the same time, they were very similar (26.4% and 27.4%). The Pareto ratio for this inventory group is 20/53.9. The second most important inventory group (B) consists of forgings and billets. These inventory items are less bulky compared to group A, but they still belong to the significant ones. The Pareto ratio for this group is 20/25.7, which means that they are items which also require the necessary attention. Group C includes the remaining inventory items.

These items can be seen as less significant. They are inventory items with 1.8 - 5.3% share on the total volume. The Pareto ratio in this group is 60/20.4. The analysis clearly shows that the important inventory items can be found especially in Group A. These two inventory items amount for 53.9% of the total volume.

The variability analysis is another method applied here. It was applied to the inventory item of concrete reinforcing bars, which show long-term large fluctuations in the monitored company. Table 3 presents the volume of sales in 2015 in the individual months. The coefficient of variation has been determined for these data. It can be determined as the standard deviation and arithmetic average ratio. The quotient is subsequently multiplied by a constant of 100. Table 3 also shows the specific values of these statistical indicators. The established coefficient of variation is 68.9%, which puts this item to the variability group of Y (50 - 90%).

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Table 1. The values of the key inventory items

Inventory type	Value (thous. EUR)	Share on the total volume (%)
Bars	2980	5.3
Slabs	14789	26.5
Billets	6500	11.7
Wires	2200	3.9
Strips	15290	27.4
Sheets	1450	2.6
Concrete reinforcing bars	1980	3.6
Forgings	7800	14.0
Burnt segments	980	1.8
Welding material	1780	3.2
Total	55749	-

Table 2. Pareto analysis results

Inventory type	%	Cumulative total	Group
Strips	27.4	27.4	A 20 / 53.9
Slabs	26.5	53.9	
Forgings	14.0	67.9	B 20 / 25.7
Billets	11.7	79.6	
Bars	5.3	84.9	C 60 / 20.4
Wires	3.9	88.8	
Concrete reinforcing bars	3.6	92.4	
Welding material	3.2	95.6	
Sheets	2.6	98.2	
Burnt segments	1.8	100	

They are therefore inventory items with a relatively high variability of consumption. Figure 1 shows a graphic development of consumption in that year. The chart clearly shows a steep inequality in consumption during the year. Given that this is a metallurgical product used in building industry, such a fact can be expected. The largest sales volumes are concentrated in the summer months, which are also important in terms of the building industry. It seems appropriate to create a higher buffer stock level for this inventory item, exactly for this period of time. One can assume that a similar character of consumption can also be anticipated in the following years, with regard to the business segment in question. A potential shortage of concrete reinforcing bars in the market in the spring months can be a complication during the creation of the buffer stock for this time period. This may be a result of the system of ordering and production in metallurgical

enterprises. It is therefore beneficial to create long-term higher inventory volumes for the items with such a high variability in consumption, because they will allow you to eliminate these risks. A loss of customers may often be a greater threat for companies than the risk of high inventory levels and the resulting costs.

A correct setting of the inventory levels, however, requires an evaluation of the volume of sales over a longer period of time, particularly with respect to the power of trends in the high-risk months of the year.

Table 3. Variability analysis – concrete reinforcing bars

Month	Concrete reinforcing bars / sales (thous. EUR)
January	90
February	106
March	89
April	120
May	380
June	290
July	330
August	260
September	150
October	105
November	40
December	20
Average	165
Standard deviation	113.8
Vx	68.9 %
Variability group	Y

## Conclusions

In today's highly competitive environment, inventories represent one of the key factors deciding about the success of companies. This research has also included an analysis of the structure and variability of inventory consumption. The Pareto analysis has been used to identify the dominant inventory items in the company dealing with the trade of metallurgical materials.

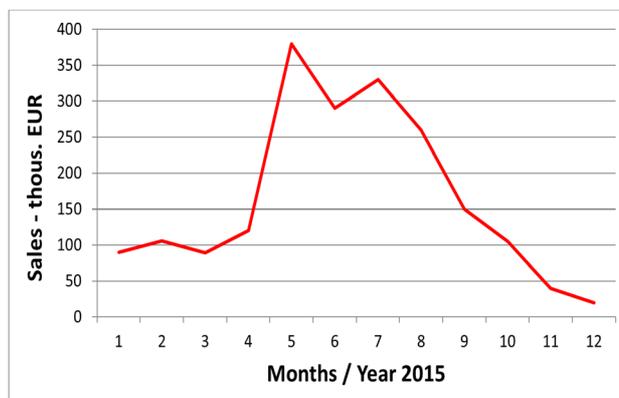


Figure 1 Development of inventory item sales – Concrete reinforcing bars in 2015

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At the same time, the research has also assessed the variability of consumption (sales) for a highly trendy inventory item. If the companies want to succeed and be prosperous in the long term, they must continually evaluate their practices and strategies in the area of inventory management.

The setting of the inventory levels should be adjusted operatively according to the current development. The dynamic changes in the market environment require a constant search for optimal solutions.

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**Review process**

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