THE UTILISATION OF STATISTICAL METHODS IN THE AREA OF INVENTORY MANAGEMENT

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Abstract
Inventory should protect a manufacturing company against unexpected fluctuations in consumption and supply and support the continuous nature of the production process. However, when creating an in-house inventory, it is necessary to consider the costs associated with their maintenance, but also the consequences associated with the risk of deficiency. The statistical methods are based on identification of relevant characteristics analyzing the earlier pattern of consumption and use of inventories. The information value of the methods based on statistical analysis increases in case the character of future consumption and its variability correspond to the previous periods. The article shows the possibility of using selected statistical tools for inventory management, especially when setting the inventory buffer levels.

Keywords: Inventory, cost, storage, profit

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 [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 [2]. 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 [3]. The sintering processes, the ore concentrate passes through prior to entering the blast furnace process, can be used as an example here. These production processes therefore require maintaining an adequate amount of inventory, due to the time demands necessary for its treatment [4].

Generally speaking, the objective of inventory management is keeping inventory on such a level and in such a composition, to ensure uninterrupted rhythmical production, as well as the availability and completeness of deliveries to customers, while keeping the total costs associated with the process as low as possible [5]. Inventory management includes, apart from the very existence of inventory and its development, other elements, such as care about the structure, the storage and use, effective management of and utilization of all available reserves – these points should be the focus of attention of each company. Effective inventory management can significantly affect the economic results of production companies.

Inventory management is a series of activities which consist of forecasting, analysis, planning, operational activities and control operations within the scope of the individual groups of inventory types and within the scope of the inventory as a whole. Proper inventory management co-decides about meeting the company objectives with optimum utilization of costs.

2. DETERMINATION OF FUTURE INVENTORY CONSUMPTION
Forecast of future development is always an essential requirement for quality planning and management. The link between the forecast and the direct control of inventory is most evident in the area of buffer stock
amount setting. The more accurately we will be able to estimate of the future situation in the deviation of demand from the mean value, the lower the buffer stock will be. Sharp seasonal fluctuations, new trends, and a turbulent external economic environment - these are the factors that make forecasting more and more difficult. Sometimes, they lead to a mistaken feeling that predictions are impossible, and therefore they are not worth dealing with. It is not so. Sometimes, it may happen that some exact forecasting methods are not applicable in practice. Wherever it is impossible to use these methods, they must be replaced with the intuitive methods [6].

Even in cases, where exact methods are used, however, you must realize that any planning – forecasting in practical application will be encumbered by certain error [7]. That is why we can say that the exact methods can be called that way mainly thanks to the clarity of their realization procedure. Standard exact methods are based on the principle of extrapolation of the development of values during previous periods. The principle is based on insetting the development curve of previous values using a straight line or curve extended into the future.

The most commonly used exact methods include, for example: the method of moving averages, weighted moving averages, regression analysis, correlation analysis and other. The methods of moving averages are based on the principle of insetting a straight line through current development, the direction of which determines the potential estimate. Regression and correlation analysis works with mathematically described curves for finding further development. However, especially large multinational companies also often use intuitive planning methods. Their principle is based primarily on experience, intuition, knowledge of the environment, the ability of analytical thinking and creativity of workers. These principles can be used anywhere, where exact methods fail – namely in cases when the historical data for the exact analysis are missing, or are highly inaccurate and biased [8]. It is optimal if the intuitive forecasts are verified using exact methods. In the event that the intuitive forecast matches the calculated values with certain tolerance, the forecast accuracy is higher. However, as the current global economic crisis has shown, there are situations in the market environment that cannot be predicted by any method.

At present, even smaller companies are trying as much as possible to estimate the current and future trends. That is why marketing surveys are often performed, using the methods of direct questioning of potential consumers. Their objective is to estimate the anticipated motivation and behaviour and decisions of consumers when creating demand. The experience and knowledge of the trends and developments of the market environment may be critical factors of success. A typical example from the field of metallurgical production is good knowledge of the forecasting worker from the area of current sales trends of metallurgical products. In the case of metallurgical companies, operative interventions in production are difficult to make and the produced assortment is often determined for several months in advance.

The costs associated with keeping inventory can be looked upon from different perspectives [9]. One of the alternatives is the classification of inventory according to the model of economic order quantity. This model divides the costs associated with inventories into two groups: the cost of maintaining inventory and the ordering costs [10]. The costs of maintaining inventory include all the items related to physical inventory possession. This involves mainly the following costs: costs of capital tied up in inventory, the cost of maintaining a warehouse, insurance costs of inventory and warehouse space, cost of risk [11].

The costs of capital tied up in inventory can be defined as potential profit that the funds intended for purchase of inventory could have brought if they had been invested otherwise. Usually, you can use the current common interest rate. The costs of maintaining a warehouse include all the costs associated with the operation of a warehouse and inventory records. The costs of inventory insurance can be defined as the amount spent on inventory insurance over certain period of time. The costs of risk represent a potential danger of future unsaleability or unusability of inventory, mainly due to physical or technological obsolescence.

The second group of costs associated with inventory management is represented by the cost of ordering. These costs include especially the costs related to monitoring of inventory consumption flow, processing,
issuance and delivery of orders, but also transport, control and storage. It is ideal for an efficient inventory management system if it is possible to calculate these costs per unit (piece, ton, packaging, pallet). Given the wide range of monitored costs, however, the determination of unit costs doesn’t tend to be entirely simple and objective. When defining the costs, it is always necessary to accept certain simplification that will make the solution easier.

3. METHODS OF INVENTORY MANAGEMENT

The basic methods, which are used for inventory management, include Pareto analysis and analysis of variability. The principle of both the methods is based on the classification of the monitored phenomena into three or more groups, while different attention should be paid to each of the groups. Pareto analysis is also sometimes referred to as ABC method in logistics, according to the number of groups and names of groups which the items are classified into. Its principle rests on the assumption that approximately 80% of the consequences are evoked by only 20% of all possible causes. For example: most of low quality products are produced in a limited number of manufacturing operations. ABC analysis is a versatile tool used for solving logistic problems. This method is popular and frequently used in logistic practice. It is time-consuming and demanding in terms of its calculation and its results are clear and transparent. The procedure of preparation of Pareto analysis can be summarized in the following points: exact determination of the values of all inventory items and their total value, determination of the percentage share of each item of the total, sorting items according to the percentage of content, determination of cumulative sums, and a classification of items into groups A, B, C or others. Group A should contain the items having approximately 80% share of the overall consumption, Group B - 15% C - 5%.

The analysis of variability is often referred to as XYZ analysis and it belongs to basic statistical tools used in inventory management. Unlike 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 inventory that is used irregularly. The items are again classified into three or more groups. Group X includes the items with highly regular consumption, which don’t have significant fluctuations in consumption. Group Y contains items that show strong seasonal fluctuations or trends. Group Z contains items whose consumption is the most irregular and forecasts of consumption are limited. The items are classified in groups X, Y, Z according to the value of the variation coefficient: X – coefficient of variation - up to 50% Y - coefficient of variation of 50-90%, Z - coefficient of variation above 90%. The coefficient of variation in essence determines the disparity of the statistical set. Greater dispersion and remoteness of the individual values from the central position means greater degree of variability in consumption. The coefficient of variation is calculated as the proportion of the standard deviation and the simple arithmetic average. The procedure of the XYZ analysis preparation can be summarized in the following points: preparation of the records of inventory consumption in given period of time, determination of the average and standard deviation, the determination of the coefficient of variation, classification of items into the individual groups. To measure the variability of consumption, it is advisable to use the data for a longer period of time.

4. ANALYSIS OF VARIABILITY OF CONSUMPTION

The analyses of the variability of consumption used data related to its amount for three selected stock items of an industrial enterprise. The consumption data are presented in Table 1. The data of consumption for the period of seven months were used for the monitored items. The inventory consumption was monitored in tonnes. The average consumption, standard deviation and the value of the coefficient of variation were determined for all the items. The items were then classified into the individual groups on the basis of the determined value of the coefficient of variation \( V_x \). Item no.1 has the lowest value of the coefficient of variation, and its consumption is therefore very easy to predict. A high degree of variability can be observed in case of item no. 3, where the value of the coefficient of variation is 96.50%. In the case of such large fluctuations, the estimate of the future inventory consumption is much more difficult. Figure 1 shows the
graphical consumption flow of the monitored inventory items. There is a clear large variance in consumption, especially in items no. 2, 3. If we look at the value of the arithmetic average of the monitored inventory items, we can see that it is very similar for all of the monitored items. However, the planned inventory consumption can use the recorded average values only for items with low variability. Multiples of average consumption can be used to create the buffer stock, depending on the delivery time or the seriousness of the risk of lack of inventory. Traditional logistic concepts of buffer stock creation can also be used for these items, based on the analysis of consumption and delivery times. The most commonly used factors determined for these indicators are their mean value and standard deviation. The concept also uses a security coefficient that takes into account the level of risk. The value of the security coefficient is based on normal division of random variable.

Tab. 1 Analysis of variability of inventory consumption maintenance

<table>
<thead>
<tr>
<th>Inventory number</th>
<th>Jan (t)</th>
<th>Feb (t)</th>
<th>Mar (t)</th>
<th>Apr (t)</th>
<th>May (t)</th>
<th>June (t)</th>
<th>July (t)</th>
<th>$\bar{x}$</th>
<th>$s_x$</th>
<th>$V_x$</th>
<th>XYZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>10</td>
<td>9</td>
<td>12</td>
<td>10</td>
<td>10,57</td>
<td>1,05</td>
<td>9,93</td>
<td>X</td>
</tr>
<tr>
<td>2.</td>
<td>8</td>
<td>14</td>
<td>18</td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>7</td>
<td>9,57</td>
<td>4,53</td>
<td>47,34</td>
<td>Y</td>
</tr>
<tr>
<td>3.</td>
<td>1</td>
<td>1</td>
<td>19</td>
<td>18</td>
<td>2</td>
<td>2</td>
<td>20</td>
<td>9,00</td>
<td>8,68</td>
<td>96,50</td>
<td>Z</td>
</tr>
</tbody>
</table>

Determining the level of buffer stock for items with high variability is very difficult. One of the possibilities is to use the exact methods of decision-making based on the simulation of the random variable. Even here, there are often great differences and deviations from the real values. The impossibility of accurate forecast of consumption of these items usually means higher buffer stocks. It is practically impossible to use forecasts based on statistical analysis of data for these inventories. If it is, in addition to that, an important commodity or an essential part, it is necessary to create the adequate stock reserve. Another important factor is the potential delivery time as well. In the case of materials with irregular and heavily fluctuating consumption, which also have long delivery times, it is impossible to apply the standard methods of inventory management.

In the case of highly irregular consumption of inventory, the company must always consider all relevant factors. High levels of buffer stock of these inventory items can often mean extremely high cost of their maintenance, which often exceed the potential costs arising from the unavailability of inventory. That is why a concrete amount of buffer stock must always be set in accordance with all the relevant factors.
5. CONCLUSION

Monitoring inventory according to its volume, but also the nature of consumption in a given period of time, can provide important information for purchase planning and inventory management. These methods can be used in the processes of metallurgical production, not only in the area of production inventory, but also for monitoring and planning of spare parts requirements, which represent a large part of the inventory. When setting the buffer stock levels, it is necessary to take into account not only the concrete volume of the given inventory, the variability of its consumption, the time of delivery, the risk arising from the possible lack of inventory, but also the eventual seasonal character. In the case of highly regular consumption of stocks, it is possible to use the methods based on statistical analysis of data. It allows you to determine the planned value of buffer stock with high accuracy. This accuracy is conditioned by the fact that the future consumption of inventory will have similar character as the analyzed data. Any extreme fluctuations in consumption based, for example, on the consequences of the economic crisis are, however, difficult to predict.

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LITERATURE


