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INTRODUCTION

Inventory management is an inseparable part of enterprise management; therefore, this process should be analyzed in terms of the functioning of the entire logistics system. There are many methods and tools in the references to support the inventory management process (Blanchard, 2007; Bril and Łukasik 2013; Hugos, 2006; Kaczorowska et al., 2019; Kotzab et al., 2005; Ling, 2007, Szymonik 2013); unfortunately, they are not widely used in many companies.

The paper presents a way of improving the inventory management of a selected company operating on the tire market. The company struggled with the bottleneck problem. The following phenomena were recognized as the causes of the problem:

- Regular increase in the number of tire sizes on the tire market (new car models);
- Assumed production plans for selected tire sizes (specific sizes) in a given period based on the demand of the entire European market;
- Extended logistics and transport cycle of tires commonly known as unique, from factories located outside Europe.

For tire sales, inventories are quite burdensome, as the tire ages quickly. In the tested company, each tire accepted for storage is described manually in Excel based on DOT (Department of Transportation) – a symbol located on the side of the tire and containing information about the place and date of manufacture. Shipping from the company's warehouse is carried out according to the FIFO (First In, First Out) principle. However, sometimes the warehouse sends tires with a better DOT (tenders and special orders with the preferred production date). When selling tires, their seasonality is taken into account. In order to increase competitiveness, the company provides some customers with a "safety guarantee" authorizing them to return unsold tires at the end of the season. Subsequently, the tires are returned to the warehouse and, unfortunately, are only good for marked down sales, because their DOT will not be acceptable next season. The sales/marketing department is responsible for organizing the sale

of tires returned at the end of the season. Getting rid of post-season tires is one of the main goals of inventory management. Tire storage is an expensive process, which is why the company focuses on their rapid rotation. Tires are delivered from a Hungarian factory and Asian factories. The company works on an integrated SAP system that links all activities throughout the company.

METHODOLOGY OF RESEARCH

Company employees were interviewed to identify problems affecting inventory management. Based on the interview, the following information was obtained:

- inventory management system,
- company inventory management purposes,
- inventory control system (method of inventory control),
- costs related to inventory (fixed and variable costs).

Based on the data obtained from the company's employees, ABC and XYZ analyses were conducted and the inventory turnover rates for the summer and winter season were calculated. Furthermore, standards were defined in inventory control for a system with a fixed delivery period.

INVENTORY MANAGEMENT

The most important goals of inventory management include:

- guaranteeing the level of appropriate service for external and internal customers, keeping in mind the quality and dependence on the whole of all completed orders,
- concept of future and current demand for all necessary goods in order to avoid production excess and deficits,
- striving to reduce costs by reducing the variety of inventories, determining the economic size of ordered lots and examining the costs of maintaining and creating inventories. (Galińska, 2016; Ross et al., 1999).

Methods to determine demand and supply

The methods needed to determine the stock demand differ from each other in the accuracy of the arrangements and the database. Therefore, deterministic, stochastic and subjective terms are distinguished. The deterministic (accurate) determination of the supply and demand of inventories includes the calculation of material demand for components and raw materials of products on the basis of product production schedules and material combinations illustrating the structure of the product. Stochastic methods predict stock demand based on consumption statistics in comparable periods of the past and anticipated trends of future changes. Expected demand is expressed based on available data and selected forecasting tools. If the use of deterministic and stochastic methods is not possible, the method of intuitive estimation based on knowledge and experience is adopted. (Ross et al., 1999; Sarjusz-Wolski, 2000).

Stock control (registration) system

Quantitative stock levels are determined using level control systems. In practice, inventory control is carried out continuously or periodically. In the Periodic Inventory Monitoring System the inventory level is physically determined and the appropriate decisions are made regularly, at each specific fixed time interval T (week, month, quarter). (Cieślak, 1997; Krzyżaniak, 2008; Ross et al., 1999).

The advantages of the periodic inspection system are:

- predictability and no need to constantly monitor reserves,
- no need to computerize the system (lower investment costs).

The disadvantages include:

- the lack of current information on the level of inventory, higher operating costs of the system resulting from the need to maintain larger safety reserves eliminating the risk of stock depletion in the inter-control period. [2.3].

In the Continuous Inventory Monitoring System, inventory tracking and relevant decisions are made in an on-line system.

The advantages of continuous control are:

- current information about the level of stock,
- lower operating costs (lower safety reserves).

The disadvantages include:

- higher investment costs resulting from the need to computerize the necessary transaction and warehouse procedures in the system (revenues, expenses),
- the need for periodic inventory of actual stocks (verification of errors, shortages, waste, theft, etc.). (Ross et al., 1999; Niemczyk, 2010).

Inventory management system

Materials Requirements Planning

(MRP) – the system is based on planning "from the end", i.e. in the opposite direction to production processes. Based on the demand for the finished product, the volume of work in progress is estimated with the next step involving the volume of ordering materials necessary for production. The basis of this system is to determine the material needs (including current reserves) broken down into time periods (planning periods). This system is based on the following sets of information:

- IMF – inventory master file,
- MPS – Master Production Schedule,
- BOM – bill of materials.

The system is applicable to both easy and difficult products made of many numbers of components. (Krzyżaniak, 2008; Ross et al., 1999; Sarjusz-Wolski, 2000).

Distribution requirements planning

DRP – Distribution Requirements Planning improves the management of the delivery of finished products to the distribution network. System mission is to control stocks of finished products, batch picking, selection and use of means of transport, dispatch of shipments etc. In companies using a given system it is often combined with the MRP system. By combining these systems, the LRP (Logistics Requirements Planning) system is created. (Krzyżaniak, 2008).

Just in Time system

The JIT (Just In Time) system consists in reducing the costs associated with maintaining inventories (maximizing inventory turnover). As follows from the inventory cost function, such an operation would not have yielded the expected results (reduction of inventory costs) without additional activities, including close cooperation with suppliers, especially those of strategic importance. The objective of this cooperation is to seek opportunities to reduce the costs of manufacturing materials by cooperating parties. To reduce inventory costs, all new investments are agreed and coordinated with suppliers so that close cooperation is accompanied by physical proximity to the plants. The JIT system is most useful in repetitive production. In contrast to the inventory planning system, it involves their "sucking" by the production and supply system after real demand for finished products. The technique of "sucking" inventory is particularly advantageous in conditions of uncertainty of demand for repetitive products manufactured in series (e.g. cars). For this reason, JIT is popular primarily in the automotive industry. The JIT concept uses the KanBan technique to shape inventory. This technique is based on the flow of planning and inventory cards accompanying the physical flow of products. The objective of the JIT system is to eliminate waste and minimize inventory. A simple reduction of inventories would mean a reduction in the flexibility of material flow for the company. (Krzyżaniak, 2008; Sarjusz-Wolski, 1998; Sarjusz-Wolski, 2000).

RESULTS AND DISCUSSION

Stock rotation in individual months

The rotation indicator allows you to determine how many times the stock will turn in a given time. In the case under analysis, tires are the stock, and the considered period is 6 months, adjusted to summer or winter time, respectively.

$$Wr = \frac{p}{z} \quad (1)$$

where:

Z – average stock (for 6 months)

P – average demand (for 6 months)

Part of the data obtained from the company is confidential, which is the reason only the data authorized for publication was placed in the work. The level of inventories in individual months is shown in Table 1.

Table 1 Summer season rotation indicator

Month	Stock level [items]	Demand level [items]
January	44,423	13,539
February	35,876	20,558
March	29,606	20,795
April	29,208	12,628
May	37,688	7,428
June	55,749	4,742
Total	232,550	79,690
Average	38,758.33	13,281.67

Source: own research

The data in Table No. 1 can lead to the conclusion that the inventory level for the summer season is 38,758.33 items, while the average demand level is PLN 13,281.67. By substituting the data into formula (1), the rotation rate for the summer season is 0.342679, which means that in the summer season the inventory turned 0.34 times in 6 months. It can therefore be concluded that the level of inventory in the warehouse is too high and the company incurs unnecessary storage costs.

The inventory turnover index for the winter season was similarly calculated based the data contained in Table 2.

Table 2 Winter season rotation indicator

Month	Stock level [items]	Demand level [items]
July	61,551	16,201
August	70,507	25,312
September	72,794	16,977
October	66,230	27,995
November	36,543	24,887
December	38,646	8,810
Total	346,271	120,182
Average	57,711.83	20,030.33

Source: own research

The data in Table No. 2 can lead to the conclusion that the inventory level for the winter season is 57,711.83 items, while the average demand level is PLN 20,030.33. By substituting these values to formula (1), the inventory turnover ratio is 0.347075. The obtained value indicates that in the winter season the inventory turned 0.35 times in 6 months. To sum up, it can be stated that both in the summer and winter season the company incurs unnecessarily high costs of tire storage because the inventories in stock are too high.

ABC and XYZ methods

For the needs of the ABC method, classification was applied to the stock, namely PCR passenger and LTR commercial vehicle tires. The division criterion was the value of the company's inventory. The assortment was sorted in descending order of the value of inventory, and then the cumulative value of shares in the company's inventory was calculated. At the end of each assortment item, A, B or C group was assigned. The division into specific

groups, due to the cumulative share of inventories, allowed to determine which groups of assortments should be given the most attention. Group A is the most important because it includes the most expensive tires with a value representing 80% of total inventory and about 20% of their quantity. Hence, the right way to deal with tires classified within group A is extremely important. The proposal of actions recommended for this group of tires is to check stock levels frequently and ensure timeliness and quality of deliveries. This group should be given the greatest attention and commitment when creating orders, as well as carry out detailed market, price and cost structure analyses. It is important to precisely set the levels of security stock. Tires in group A should be stored in a warehouse so that they are as close as possible to the issue zone, in the places where it is most convenient to collect them, which may shorten the time of issue and delivery of the goods to the customer. Group B consists of tires with an average value of around 15% of the total value both in quantity and in the inventory value of inventories. Group C consists of mass stocks (60%-80% of the range) and a very low share in the value of all stocks. Group C may be subject to simplified purchasing procedures; however, this group should not be underestimated. (Galińska, 2016; Kaplan, 2000; Sarjusz-Wolski, 2000).

The classification of the materials made it possible to extend it to the XYZ classification, the criterion of which is the regularity of inventory consumption. This classification assigns materials to one of three groups according to the following criteria:

- Class X – tires that are constantly and regularly used making their consumption easily predictable and no high level of safety is required.
- Class Y – tires with a variable level of consumption due to seasonality, it is required to maintain a specific level of safety stock.
- Class Z – tires with an irregular degree of consumption, which is difficult to estimate. This group requires maintaining a high level of stock.

Table 3 includes homogeneous groups due to forecasting possibilities or purchasing strategies. Identifying individual groups allows determining the importance of individual groups and supports decision-making processes. The ABC/XYZ matrix classifying materials is presented in Table 3.

As a result of the ABC/XYZ analysis, specific actions can be taken in the area of material management (Table 4).

The XA group of tires is the most important group and the company should devote most time and diligence to it because it has the highest value. Stocks in this group should be low because they carry a high accuracy in forecasting their consumption. The "Just In Time" inventory control method can be applied to this group. Materials in the ZC group are tires in which routine operations are carried out for supply reasons because their value is low.

The level of stocks in this group should be high because the forecasts for this group are quite low and the demand level for this group is unknown.

Table 3 The ABC/XYZ matrix classifying materials

	X High consumption materials	Y Medium consumption materials	Z Low consumption materials
A Expensive materials	AX High accuracy of the demand forecast	AY High accuracy of the demand forecast	AZ High accuracy of the demand forecast
B Medium-cost materials	BX Medium accuracy of the demand forecast	BY Medium accuracy of the demand forecast	BZ Medium accuracy of the demand forecast
C Low-cost materials	CX No accuracy of the demand forecast	CY No accuracy of the demand forecast	CZ No accuracy of the demand forecast

Source: (Krzyżaniak and Cyplik, 2007; Kaczorowska et al., 2019)

Table 4 Stock keeping strategies based on the ABC/XYZ method

	A	B	C
X (high)	Just In Time		Overtaking control
Y (average)		Control by Max-Min stock inventory	
Z (low)	Control according to the status of ordered inventory		Control by programs and inventory

Source: (Łangalis, 2009)

Based on the ABC and XYZ methods, it is possible to propose the introduction of the JIT system. The JIT system will reduce production costs by reducing storage costs. It is important that all company employees are fully involved in the implementation of the JIT system. The correct response to alerts received from production and from warehouses is the key to reducing or minimizing inventory at the JIT-related center. The goal of such activities is to save even the smallest storage space and reduce storage costs.

Definition of standards in inventory control of the system with a fixed delivery period

The second suggestion is to introduce a company inventory management system with a fixed delivery period. The company wants to reduce inventory at warehouses, because seasonality has a huge impact on stock. During the interview, information was received that the company orders tires monthly at fixed cycles from a Hungarian factory. Furthermore, the company also has 100% demand for tires from Korea and China, which are ordered for production for the summer season in October and winter season in April. The company that stores tires guarantees a maximum inventory of 50,000 items. Due to storage costs and DOT issues in the later season, the inventory is limited to 10,000 tires from a given season. A system with a fixed delivery period involves periodic regular delivery planning. The Q delivery quantity is ordered to replenish the stock in Zi

Assuming that the annual consumption of tires is 227,281 items, the number of business days in the company is 300, and the delivery time is 30 days, further standards can be calculated:

- Estimated average daily tire consumption – p :

$$p = \frac{227281}{300} = 758 \text{ [items/day]} \quad (2)$$

- Minimum stock level – Z_{min} :

$$Z_{min} = \frac{227281}{300} 30 = 10606 \text{ [items]} \quad (3)$$

According to the assumptions of the system with a fixed delivery period, the company should order tires every month, and then the outlays for storing unnecessary tires will not be high. In the surveyed company, the ordering period for tires is 30 days, the maximum stock is 50,000 tires. The features of this system are an increase in the demand for tires and, consequently, an increased volume of orders. With the fixed delivery period, the company does not have to keep checking the state of the tire inventory while it orders tires in cycles, regardless of their size. Also, when ordering tires, they can be grouped, which will help eliminate unnecessary reserves. It should be noted that the company has a deficient information system about the stock while the specified level of safety stock is very high. With the fixed delivery system, the company should reduce the costs of tire storage, but the increased levels of orders can increase the operating costs.

CONCLUSION

This paper presents a method to improve the inventory management process at a tire sales company. Based on data obtained from the company, the rotation rates for the summer and winter season were calculated, where the average level of demand and the average level of inventory for a given season were determined. The obtained index values showed that the company inventory level in the warehouse is too high, which causes high maintenance costs.

Also, ABC and XYZ analyses were performed. The analysis identified two strategic tire groups:

- tires with the highest demand on the market and representing the highest company value,
- tires with the highest share in the number of products and representing the lowest value.

As a result of the analysis, the tires were classified into 9 groups, increasing the accuracy of forecasting the demand for them and improving the method of storing the goods in the warehouse, to allow the collection of materials progressing quickly and efficiently. Based on the analysis of the company operations, it was found that the best inventory control system is a system with a fixed delivery period. The paper calculates standards for inventory controls, allowing to determine the average daily estimated demand for tires and the minimum level of inventory in the warehouse.

The implementation of the proposed methods and tools for inventory management allowed the company to eliminate unnecessary inventories, reduce storage costs and minimize inventory control. In addition to economic benefits, the company image also improved, as customers began to receive deliveries on time.

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Abstract: In a well-organized company, stock levels are precisely planned. In order to optimize inventory, various analyses of inventory usage are carried out in terms of their quantity and status. The work presents research on improving the method of managing inventory in the tire industry using the example of a selected company. The company operates warehouses in which tires for passenger cars and vans are stored. Products stored in warehouses ensure high standards. The company focuses on individuality and has a strong market position. The paper presents the results of the ABC and XYZ analysis that allow grouping tires by demand, value and number. The criteria for choosing the ABC/XYZ method are a simple way of use and low financial outlays, in contrast to such methods as MRP or just in time. Furthermore, calculations of such standards as rotation ratios for individual seasons and optimal inventory were carried out. The rotation indicator allows determine which goods are sold quickly and which goods are selling poorly, and therefore the costs associated with their storage are probably higher than from the sale of profits. As a result of the analysis, improvements were made to the inventory management system. The implementation of the proposed methods and tools for inventory management allowed the company to eliminate unnecessary inventories, reduce storage costs and minimize inventory control.

Keywords: inventory management, inventory costs, inventory rotation, inventory