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Towards an Integrated Inventory Management Process

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Abstract

The most serious inventory management problems are related to poor inventory management – stock shortages or surpluses. Too much inventory reduces competitiveness, increases goods depreciation and ultimately natural losses. A very important aspect is the loss of sales due to a shortage of goods, although this is much less felt and therefore much less analyzed. The aim of the study is to identify the main problems of inventory management in distribution companies and provide possible solutions to these problems. The paper analyzes problematic aspects of inventory management processes, highlighting the advantages and disadvantages of the major applicable inventory management models used. A qualitative study (experts survey) was also conducted and an integrated inventory management model called "Min-Max" was developed to address problem questions of inventory management. The essence of this model is to integrate and present principles and methodologies for managing inventories to maintain optimal levels of goods in distribution companies.

Keywords: *Inventory, Models, Process, Distribution, Systems, Survey.*

1. Introduction

Inventory is a short-term asset that an enterprise uses to generate income in one year or one business year (Mackevičius & Valkauskas, 2012). Inventory is sold by suppliers and these are existing raw material, complete and ready-made products.

Inventory management is one of the most sensitive issues in managing an organization. Although the problem of inventory management is already analyzed by multiple authors, the problem remains relevant under ever changing economic conditions as there is no single and standard solution.

Effective inventory management is essential in any type of business operations (Kumar & Kumar Singh, 2016). A frequent problem for businesses is the freezing of funds with too many inventories. As a result, companies face problems such as stock depreciation, damage, natural loss, high storage, and service costs. This situation is encountered by many companies that are poorly managing their stocks. According to Zinkevičiūtė & Vasilis Vasiliauskas (2013), a proper inventory management improves inventory turnover and helps manufacturing companies reduce their frozen capital. When it comes to managing inventory at distribution companies, it is important to mention that problem also arises when there is a shortage of production, i.e. loss of sales. Excess stocks reduce competitiveness and the aforementioned problems are encountered: depreciation of goods and, ultimately, a natural loss (Jasinavičius, 2015).

Distribution companies tend to focus on those aspects that could make a more efficient use of available capital, a better warehouse size reducing; therefore, the required resources. However, there is still a lack of research to address the challenges of existing frozen funds, overstocking, depreciation, damage, natural loss, high storage, and servicing costs.

A particular analysis of the company's inventory management shows the problems that arise when production is in short supply, possibly losing sales.

There is no single standard solution to the problem of inventory management as conditions are different in every industry, company, and include many different functions and constraints. This problem pertains to the development of mathematical models and the establishment of an optimal inventory management strategy. In the context of uncertainty and variability, a special attention is to be paid to new and effective inventory management models.

It is therefore important to find a robust solution, easily and rapidly implemented in changing environments, that can be used to integrate different model principles and create a unique company inventory management system.

The aim of article is to determine major problems of inventory management in distribution companies, provide possible solutions to these problems using qualitative research (experts survey), and to present an integrated model of inventory management justifying its need.

2. Literature Review

Inventories are the tangible assets in the possession of an enterprise that it expects to sell or use directly in production within one operating cycle of the enterprise. Depending on the nature of the business, inventories

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may vary. The most authors distinguish the following main groups of stocks:

- Raw materials and consumables;
- Unfinished production;
- Manufactured products;
- Purchased goods for resale.

Inventory management is one of the most sensitive issues in managing an organization and solutions were researched by multiple authors: Christopher (2016), Chang (2004), Kostic (2009) analyzed the importance of the EOQ (Economic Order Quantity) inventory management model integration in the supply chain. Wagner-Whitin (1958a, 1958b) relaxes the EOQ assumption where demand is known in advance and constant over time and turns the attention to systems where demand is effectively known in advance, but varies with time. Additionally, Deng and Yano (2006), Geunes et al. (2006), and Chen and Simchi-levi (2012) work on an extension of the Wagner-Whitin problem dealing with single-item models with price-dependent demand. Several other researchers (Silver, 1976; Atkins and Iyogun, 1988; Joneja, 1990) have proposed heuristics for the Wagner-Whitin multi-item inventory model. Das et al. (2004) researched the importance of inventory management in the company; Mula et al. (2006) analyzed the problem of inventory management under uncertain conditions; Ziukov (2015) also analyzed inventory management models under uncertainty; Mackevičius & Valkauskas (2012) analyzed complex inventory management methodology; Vasilienė-Vasiliauskienė et al. (2018) analyzed the possibilities of selecting inventory management models. According to Muckstadt & Sapra (2010), inventory exist only due to differences in the market between the supply of goods to a particular location and the consumption (sale) of it at that location.

Considering variability condition, the efficient inventory management models are particularly important (Ziukov, 2015). Under business environment conditions, there is no single and best-fitting inventory management model. It is thus very important to find a solution by integrating principles of different models and developing a unique inventory management system. Therefore, companies, namely distribution companies, require methodologies that are based on inventory grouping according to certain attributes and in this way apply essential principles by simplifying the entire inventory management process to a minimum (Wild, 2018). According to Farahani et al. (2011), the essence of inventory management is properly to propose answers to these statements.

Distribution is a method to deliver products to customers in the most cost-effective way possible (Dent, 2014). The main task of distribution is to deliver goods to potential customers on time and place (Stoll et al., 2015; Murphy & Wood, 2008). In the case of services, allocation is essentially limited to providing access (Armstrong et al., 2011).

The main difference is that the manufacturing company adds value by turning raw materials into semi-finished products or products. According to Zinkevičiūtė & Vasilis Vasiliauskas (2013), these are the so-called benefits of form.

In a logistic system, inventory storage or warehousing is understood also as a warehousing system. This system performs functions: inventory storage and/or distributing, sorting and packaging raw materials (Dent, 2014). Stockpiling largely depend on selected methods and directions in which supplies are obtained from suppliers located in different parts of the world. It is also important to select adequate and optimal distribution scheme as the size of the supplies has an indirect effect on the inventory cost and tends to minimize it (Urbonas, 2005; Silver et al., 2017; Staknys, 2019). In this framework, inventory accumulation is impacted by the way of transportation and the application of a simple or complex warehouse system. Consequently, Urbonas (2005) points out that the main feature of a conventional warehouse system is that the stock is shipped directly from the supplier's warehouse to the end users, while, when a more complex warehousing system is applied, stocks are stockpiled through intermediary distribution centers. A visualization of examples of the cross-docking principle is presented on Figure 1.

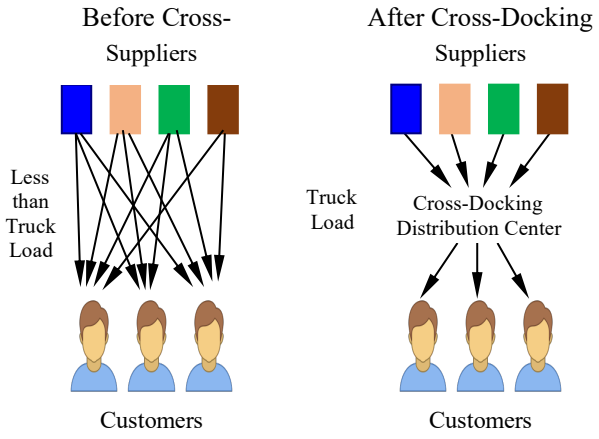

Fig. 1 Examples of Stock Distribution Systems. Source: by the authors according to Urbonas (2005).

Finally, inventory management encompasses all activities pertaining to ordering inventory, forecasting its needs, eliminating unnecessary inventory, and other activities that are primarily aimed at optimizing company's inventory-related costs: warehousing, shortage, loss, ordering, replenishment frequency… (Ziukov, 2015).

In order to avoid stock shortages, safety stocks are introduced in the models - they are based on the experience of the company's purchasing / sales department and the reliability index of the carriers used.

Summarizing the theoretical part of inventory management, the problem of practical applicability becomes clear. Although in theory inventory management models work, in practice it is not possible to define many variables precisely; it is why they are very labor-intensive. Employees of the company's purchasing department need to set different models for each product or group of products in order to manage the company's inventory as efficiently as possible. It is important to note that inventory management is also a process that costs the company money, so it should also be organized as efficiently as possible, more particularly in times of crisis. In this framework, In the start of COVID-19 event of panic and unexpected surges in supply and demand, virtually every inventory management strategy was ineffective. However, when assessing and analyzing inventory management in various enterprises, it can be concluded that, in general, large enterprises have inventory reserves that allow them to operate smoothly in the market for a short time (Grzegorz et al., 2021). Furthermore, during the COVID-19 pandemic, many SMEs have started to base their inventory management policy on this strategy. The advantage of such an action is certainly protection against the supply problem and the scale effect (Baker et al., 2020). Today, more than two years after the start of the COVID-19 pandemic, there are strong signs of a global economic recession involving galloping inflation and major disruptions supply chains with at least erratic deliveries, heavily impacting inventory management. Companies must therefore be ready to deploy various actions and measures capable of trying to overcome the difficulties encountered. Among these measures, "reducing the number of product varieties (SKUs) and focusing on the fast sellers and reducing the number of suppliers, focusing procurement on large and robust ones" (Sheffi, 2022) would allow, for example, a more accurate forecast analysis of demand, capable of contributing to more efficient inventory management (Sheffi, 2021) and more resilient supply chains (Sheffi, 2020). Finally, most of the tools and methods chosen in times of COVID-19 can help companies to face uncertain contexts, important crises, radical changes, and constrained markets to manage the economic consequences that we face, guaranteeing as much as possible sufficient stocks to meet customer deliveries within the timeframes, contributing to the global recovery (Alvarez et al., 2020).

3. Inventory Management Models and Systems

Inventory management models are being developed to ultimately optimize the use of financial resources (Bose, 2006). As a result, choosing and adapting an appropriate inventory management model or combination of models not only brings associated benefits to the company, but it may also provide financial advantages, such as reducing capital requirements in frozen stocks, improving order fulfilment, and increasing sales revenue (Saxena, 2009).
Below, we will focus on some tools and methods used in inventory management.

Material Requirements Planning (MRP). Material Requirements Planning Model combines solutions in regard to goods, intermediate products (Work In Progress), and materials to meet customer demands in short to middle term (Raup et al., 2015). MRP remains a computing technique that converts main product graph into detailed graphs of materials and components used in final products. Detailed graphs identify the quantities of each raw material and its components. It also specifies when each item must be ordered and shipped to fit the main graph of final products (Kumar & Singh, 2016).

XYZ Model. XYZ analysis is applicable to assess predictability (Stoll et al., 2015). Contrary to the ABC method, the XYZ method classifies inventory items according to the variability of their demand.
X: Items are characterized by steady turnover over time. Future demand can be reliably forecast.
Y: Although demand for Y items is not steady, variability in demand can be predicted to an extent. This is usually because demand fluctuations are caused by known factors, such as seasonality, product lifecycles, competitor action or economic factors. It is more difficult to forecast demand accurately.
Z: Demand for Z items can fluctuate strongly or occur sporadically. There is no trend or predictable causal factors, making reliable demand forecasting really tricky.

Booking System for Fixed Periods and Time (Min-Max Model). The order quantity varies depending on how many units are in stock at the time of the new order. In most cases, inventories are calculated at the end of the period and bookings are made on the basis of the calculated amounts of inventory. Based on the principles of the safety inventory, the Booking System for Fixed Periods and Time guarantees greater inventory that should suffice until next delivery. The advantage of this model lies in the simplicity of its applications.

ABC Model. The ABC analysis is a model that defines the categorization of inventories by the items turnover level. The ABC analysis is based on ABC method of ranking stocks using similar proportions as in Pareto's Law, except that there are three groups instead of 2 (80/20). The foundation of this analysis is the sales analysis of products, which enables to determine which products are sold the best and, based on this criterion, inventory demands are analyzed (Reid & Sanders, 2007; Kimball & Ross, 2013; Wisner et al., 2017).

In this article, the ABC method is favoured in comparison to the XYZ one insofar as the latter focuses

on the variability of demand, that is to say on its volatility which remains a less natural and concrete concept than the observed physical turnover of items that is a more intelligible notion for practitioners.
In general, a correspondence exists between items in the category A and those with very low volatility, as well as between those in the category B and items with intermediate volatility that can take into account specific economic factors, in addition to parameters such as the seasonality, the life cycle of products… and between those of the category C generally characterized by a very high variability, making any forecast analysis almost inaccurate.

Economic Order Quantity Model (EOQ). Economic Order Quantity Model determines the optimal order quantity that minimizes the total variable costs associated with stock holding and ordering. This basic model has certain limitations: steady demand, no allowed shortages, and a fixed replenishment lead time. Some mathematical calculations are required to obtain the optimal order quantity. The following basic formula (Eq. 1) is used to calculate *EOQ*:

$$EOQ = \sqrt{\frac{2PD}{CV}}, \qquad (1)$$

here: *EOQ* – quantity of units ordered; *P* – order processing costs; *D* – annual product demand in units; *C* –holding cost per year as a fraction of unit cost ; *V* – Average unit cost

- The *EOQ* model can be extended to include transportation rates, transportation rate discounts, and the benefits of private transportation (Kakneviciūtė & Vasilienė-Vasiliauskienė, 2015). Minimal changes to this model allow to take into account the obtained discounts due to volume or transportation. Discounts reduce the cost per unit and so will also change the amount of the ordering cost. More generally, optimal order quantity helps management to select the correct order size to minimize overall costs, but this model does not determine the correct order time. When changes are made to the basic model due to discounts received when purchasing a certain amount of inventory or goods, the value of the calculated *EOQ* will change as discounts reduce the unit cost. An adapted formula is provided below, while the presence of lot size-based quantity discounts tends to increase the level of cycle inventory. Nevertheless, quantity discounts can increase the supply chain surplus for the following two main reasons:
    a. Improved coordination to increase total supply chain profits;
    b. Extraction of surplus through price discrimination.

$$Q^1 = \frac{2rD}{c} + (1-r)Q^0, \qquad (2)$$

where in Eq. (2) Q^1 is maximum quantity that can be ordered to receive a discount; *r* is price discount in percentages if a large quantity is ordered; *D* is annual demand; *c* – annual inventory storage costs (%); Q^0 is EOQ before the adjustment (i.e. before receiving any discounts).
Even though that inventory control models can be deployed in theory, many variables cannot precisely be defined in practice; hence, they are very prone to manual work. In order to manage their inventory at maximum efficiency, companies must set different models for each product or group of products.
In this framework and in order to ensure an optimal inventory management particularly in distribution companies, we propose to conduct a qualitative assessment.

4. Qualitative Assessment of Inventory Management: Focus on Lithuanian Distribution Companies

Taking into account both scientific and practical problems, the aim of this study is to present a stock management optimization model in the Lithuanian distribution companies sector after the analysis of scientific literature and empirical research. Experts' survey based on a questionnaire - interviews with supply chain managers of distribution companies - was selected for the research. The survey method is applied in sociology and social psychology to obtain oral information provided in the research program; this method being considered to be one of the most effective methods of qualitative research (Tidikis et al., 2017). The main reason for choosing the qualitative (experts' evaluation) method is that experts evaluation allows to obtain solid results in order to achieve objectivity in the analyzed problem (Tidikis et al., 2017). A structured interview method was then chosen in the work and a questionnaire was prepared. In fact, the structured interview was chosen because it ensured and allowed the comparison of the experts' opinions with each other. Therefore, it has become possible to perform a detailed analysis of the experts' opinion, which allowed to obtain information on inventory management. Additional information was also sought from the personal experience of experts and direct encounter with inventory management issues. Inventory management experts were interviewed during the interview. According to Kardelis (2017), the survey of purposefully selected people-specialists with knowledge in a certain field allows to achieve scientific objectivity.
The experts were selected on the basis of the principles of the experts' evaluation methodology. They were also selected taking into account their experience in the field of distribution, as well as the fact that they are directly confronted with the inventory management

problems of distribution companies. The aim of the face-to-face interviews was to identify the main problems of inventory management and their solutions, to analyze the opinion of experts on the advantages and disadvantages of inventory management methods used in distribution companies. The experts were asked questions to assess the possibilities for solving the problems. The structure of the interview questionnaire is presented in the appendix.

5. Inventory Management Evaluation in Distribution Companies: Experts Evaluation

In order to get a clear overview and significant assessments, 30 experts were finally selected from Lithuanian distribution companies. To evaluate as closely as possible the adequacy of the inventory management models with the practical problems encountered, the 30 experts interviewed during brainwriting and restitution sessions based on the questionnaire in the appendix were divided into 3 homogeneous groups E1, E2, and E3 of 10 people. This way of proceeding made it possible to guarantee the anonymity of the responses while allowing an exchange between the experts, freed from the conformity bias characteristic of the brainstorming method (Diehl & Stroebe, 1987).

1. Experts were first asked to indicate the main inventory management problems faced by Lithuanian distribution companies. Experts were identified as three groups of experts E1, E2, and E3. The E1 experts pointed out that the main consequence of mismanagement of stocks is a shortage or surplus of stocks, both of which are due to uncertainty in demand. The E2 experts, meanwhile, detailed a wider range of issues: maintaining a wide range of divisions, their turnover and customer satisfaction, and the issue of uncertainty, as it is difficult for companies to estimate how often to bring goods, as one or more customers can buy the period until the next delivery will last. Meanwhile, according to the E3 experts, the main problem is the lack of understanding of the role / benefits of purchasing (purchasing department). The experts provided statistics that support his opinion.
2. In the second question, the experts were asked to name the reasons why companies face inventory management problems? The E1 experts pointed out that the main reasons for the resulting inventory management problems are the supplier's reliability to deliver the ordered goods on time, as well as the uncertainty, as the experts pointed out - unpredictable future market demand. The E2 experts cited reasons such as a lack of staff qualifications, as well as the company's desire to have all the goods in stock, even those that are not in demand, i.e. have been sold one or more times. The experts stressed that the lack of specialized programs is one of the main reasons why companies face inventory management problems. According to the E3 experts, the problem is that there is a perception that anyone can manage inventory, as well as choosing unreliable suppliers, and the attitude that buying cheaper will earn more.
3. The third question asked whether Lithuanian distribution companies pay sufficient attention to inventory management. The E1 experts pointed out that, to date, illiquid stocks exceed the limits of reasonableness - companies do not write off goods, but, in reality, they should be written off -. Also, borrowing money from banks is higher than for goods with a balance of more than a year. If stock management in companies were carried out in an orderly and responsible manner, the experts believe that companies would lose so much money to borrow from banks. Company managers do not understand the importance of inventory for their operations and financial success, but also do not see the shortcomings of inventory management. Experts E2 and E3 pointed out that the lack of focus on inventory management is reflected in the matching of order quantities to real demand, i.e. the level of stocks generally considered to be in line with current demand - so both experts pointed to the main cause and effect of the lack of attention - was the high level of illiquid stocks.
4. In the fourth question, the experts were asked to indicate the main factors influencing the efficient management of stocks in the company. Experts E1 and E3 indicated that the key factors should be the precise determination of the range (for each unit) first. The next factor is the location of the goods sold only, i.e. correct layout, unloaded shelves as unsold goods involve financial loss. Therefore, determining the appropriate / optimal amount has a direct financial impact. The E2 experts pointed out that, in order to achieve effective inventory management, companies should first of all eliminate the shortcomings by identifying the main inventory management problems they face and taking appropriate decisions. Experts also agreed that to date, companies do not have a database for inventory management, which would allow clear monitoring of inventory movements, prompt response to inventory

declines and, conversely, the trend change in their demand.

5. In the fifth question, experts were asked to indicate the criteria on the basis of which stock levels should be formed. The E1 experts indicated that inventory size should be based on the ABC model, turnover, ROI, XYZ, and range. The E3 experts added that the company's strategy is a very important criterion and agreed with the E1 experts on the formation of the range according to ROI. Meanwhile, the E2 experts identified and detailed the main criteria: sales volume during the last period; long-term sales trend; planned marketing and sales promotion campaigns in retail outlets; new customers are planned; cargo delivery term.
6. In the sixth question, the experts were asked to indicate on the basis of which mathematical calculations a forecast of sales of goods for the following period should be made. The E1 experts pointed out that to date it is not possible to do this accurately enough with the available computational resources - too many objective and subjective factors, so the need for model integration was again emphasized here. Experts E2 and E3 indicated that each company must evaluate the application of the model according to the specifics of the activity and the need. Experts agreed that the most appropriate models would be trends, moving average, MIN / MAX, sales forecast plans - experts assessment. However, he stressed the need for an adapted model that would also assess the impact of seasonality and demand uncertainty as efficiently as possible.
7. In questions 7 to 9, experts were asked to name the advantages and disadvantages of the Fixed Period and Time Ordering System, the ABC Method of Determining Stock Needs, and the Economical Order Size Model (Table 1).
8. The tenth question asked how the integration of the principles of the different models would help to create a unique model for the efficient management of stocks in distribution companies. All experts tended to agree and indicated that the principles of the different models should be integrated: trend, moving average, sales plans according to experts and the principles of the MIN / MAX model. However, he emphasized that a unique model had to be adapted to each product or group of products, and that the first step was to set the right range and set the right price. Based on experts' insights, an inventory management optimization model is presented, which would allow inventory management according to the methodological principles of the model.

Inventory is particularly important in distribution companies, allowing to ensure that demand is satisfied on time. For this reason, inventory accounting and management is a very important area of business for companies. Effective inventory management enables companies to improve their performance results. Inventory management must be organized in such a way as to meet the demand for both internal and external customers at all times. On the other hand, inventory must be managed in a way that helps improve company's financial performance.
Consequently, an experts' assessment method was carried out in order to identify the main problems of inventory management and its solutions, wishing to analyze the advantages and disadvantages of inventory management methods used by distribution companies (Jarašūnienė et al., 2019). The model of inventory management under uncertainty (Figure 2) was presented and questions were submitted to the experts.

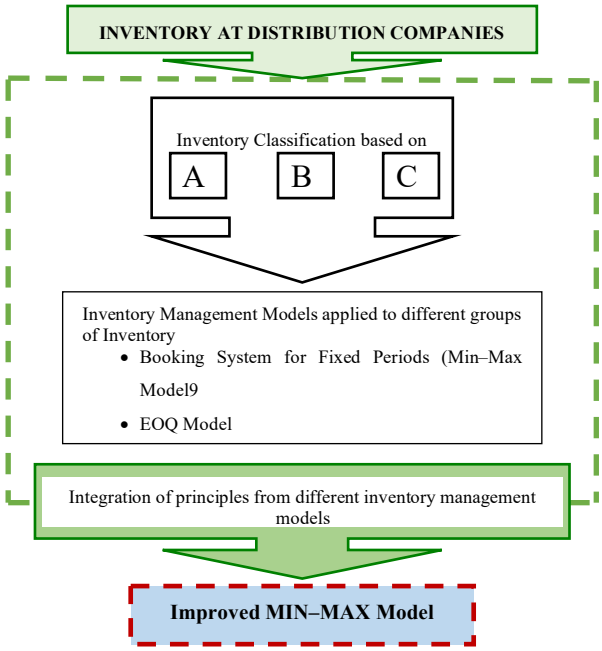

Fig. 2 Inventory management model under uncertainty. Source: developed by Authors.

Table 1 presents a summary on experts' views.

Table 1: Advantages and disadvantages of the Models (assessment of experts' opinion)

Model (system)	Advantages	Disadvantages
Booking System for Fixed Periods and Time	Enables to determine the importance of the product; Acts as a tool to refuse illiquid goods and to direct company's finances to obtain the right goods.	Receipt of goods is not daily, but occurring 2 times per week, e.g. in case of sudden warming, we can encounter a backlog; goods not being available until next receipt. In

		fact, sales in the Lithuanian market are not stable; therefore, the rarer the receipt, the more frequent the absence of goods. At the opposite, if goods are transported every day, a heavy workload is placed on employees, warehouse, and documentation.
ABC method	Prioritize control of high-priority inventory over inventory that has a lower impact on your bottom line.; Everything is calculated and the process automation does not require human intervention (the costs of orders become cheaper, etc.).	ABC method uses only one parameter. The use of the variety of parameters makes the drawbacks avoidable. Problem with the latest trends because of no history or accurate expectations. Experts' assessments are required that can induce some biases.
Economic Order Quantity Model		Too theoretical and simplistic model. Inability to evaluate the diversification of transported goods.

In general, Economic Order Quantity Model was assessed skeptically by experts. They claim that costs are not tailored at each item, but rather are averaged out. Costs are only calculated in accordance with the product averaged value, while variable costs and particular service transportation costs for example are not taken into account. The Economic Order formula could be more fruitful with smaller assortments and a deeper products segmentation allowing to converge towards real costs and not the averaged ones because large lots of goods, multi-products, and different sizes make this model aimless.

In the tenth question, participants were asked to determine which principles from different models should be integrated to establish a unique model to manage inventory in distribution companies effectively. Experts agreed upon and claimed a clear improvement of the inventory valuation methods.

6. The Improved MIN-MAX Model

The aim of the presented model is to provide principles and methodologies on how inventory should be managed to maintain optimal inventory levels and ensure corresponding service levels, i.e. not to freeze an excessive working capital, save on storage space, but at the same time not to lose sales due to insufficient inventory levels in companies. The essence of the improved Min-Max model is to deal with fluctuating inventory demand and received supply; thus, MIN and MAX values must be flexible and re-calculated at each point in time.

Based on this advanced model, the principles of system operation are divided into two main stages.

Stage I. Product inventory analysis should be carried-out by first deploying the ABC method. The ABC analysis determines which inventory should be prioritized. After completing the ABC analysis, the next step is to determine the objectives of inventory management. The improved MIN-MAX model is equally suitable for all types and groups of inventory management to obtain either one of the following objectives: reducing inventory values; reducing storage space; reducing the share of uncompleted orders due to insufficient inventory.

Stage II. An inventory with insurance coverage is determined. For this type of inventory, the following formula (Eq. 3), based on the safety inventory theory, is used:

$$C_{sl} \times S_{dd} \times D_{aver}, \tag{3}$$

where: C_{sl} – service level coefficient; S_{dd} – standard deviation from delivery time; D_{aver} – average demand (pcs / day).

Determining the appropriate service level for a given inventory unit is basically balancing inventory cost and inventory price. Therefore, service level is a very important variable to estimate, matching with the wished inventory levels by category or product family as a result of the ABC analysis in stage I and simultaneously taking into account some outputs coming from an external forecasting method. As demand in the free market is constantly fluctuating and uncertainty prevails, adapting to changing situation is necessary in order to manage inventory in an effective manner. With the help of the model, it would be possible to calculate the inventory sufficiency and critical order points by using the operation principles of the provided process:

1. Each item is assigned a certain amount of inventory (this amount is determined by considering sales, as well as the amount of inventory that will be required before the order is executed, i.e. amount of sales per period + safety inventory);
2. Each quantity of inventory shall be divided into three zones: red, green and yellow remembering the concept of the ABC

analysis. Each zone is equal to one third of the established inventory level;

3. A query report is generated daily showing how many days in a row the inventory is located in a certain zone. Based on this, the amount of inventory (the amount in a warehouse or ordered amount) is formed according to all conditions.
   3-1- If stocks have been in the green zone for a consecutive period longer than the replenishment period, then the sales level has fallen and there is too much stock in the warehouse, so there is no need to place an order. The amount of inventory is then reduced by a quarter. The next inventory recalculation begins when inventories fall below the new reduced inventory level.
   3-2- If the stock level changes from green to yellow at any time, the calculation of the stock reduction shall be stopped. Stocks are considered to be moving as planned.
   3-3- At the level of stocks in the yellow zone, the system calculates "rolling" historical sales during the replenishment period and calculates the adequacy of stocks for future periods according to the formula: "current stocks - current sales during the replenishment period - safety stocks". When this number approaches "0" or another set order point, a stock order is formed for the supplier.
   The specific stock level at the time of ordering is fixed depending on the delivery conditions. If orders can be placed on a daily basis, then inventory is ordered when the inventory level reaches "0" according to the formula, if orders are placed on fixed days, the remaining days are added to the order fulfillment period and the order quantity is formed accordingly.
   3-4- If the stock level in the red zone stays more than 33% of the time during the replenishment period, the stock level is increased by 33% and the stock increase amount is added to the order. In the event of an increase in stock, the subsequent increase in stock is possible only when the stock arrives at the warehouse.

Calculations were performed based on the model proposed. According to the classification of stocks by groups in the study, products A group was chosen to evaluate the performance of the model. Taking into account the sales of this group of goods, the level of inventories is presented using different models; other conditions remaining unchanged (see Figure 3).

As can be seen from the example above, the calculations have confirmed that deploying the proposed model allows better to manage inventory. The model organizes information and indicates how inventory should be managed theoretically and specifies the sequence of actions and models for managing certain types of inventory. The model would help to reduce general inventory under demand fluctuations.

It is relevant to maintain an optimal balance for fast moving products, i.e. neither too much nor too little to avoid losing sales and, at the same time, not freezing money in excess inventory, albeit moving fast enough; where greater problem lies in inventory quantities and emerging warehousing problems, reduction of storage space and cost requirements.

The human resources alone cannot handle high inventory levels and different sales curves. If there are several dozen types of inventory, it is still possible to calculate inventory needs and sales manually. However, if there are more types of inventory, a corresponding computer system is required to calculate the conditions described in the improved model to make certain conclusions.

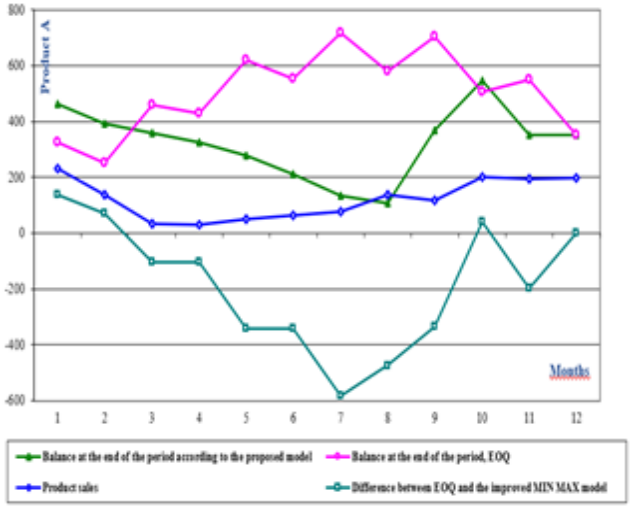

Fig. 3 Inventory levels for products A group by applying different models under non-changing conditions. Source: compiled by authors on the basis of mathematical calculations.

7. Conclusions and Further Research

A process for optimizing inventory management has been proposed on the basis of a theoretical review and a field approach, nourished by experts from Lithuanian distribution companies. The system developed, integrating principles of different models, was applied in the Lithuanian context, but its scope of action goes beyond and the research carried out through this article makes it possible to develop certain recommendations capable of improving inventory management.

1. An analysis of inventory management suggests that, due to ever-changing economic conditions, inventory management remains a topical issue, as there is no standard solution for inventory management – the conditions are unique within each company and include

many different functions and limitations. This problem pertains to the development of mathematical models and determination of the optimal strategy for inventory management.

2. When analyzing the specific case of distribution companies, it is very important to emphasize that, unlike in manufacturing companies, the basis for operational efficiency is the preparation, evaluation and selection of alternatives for the formation of goods and information flows taking into account costs and customer service needs. Distribution companies must design and implement delivery planning, market supply planning, and inventory management with these goals in mind.
3. According to the research, it was clarified that the major consequence for poor inventory management is the surplus or shortage of inventory – both consequences stem from demand uncertainty.
4. A research on economic order quantity for different product groups has confirmed that the model should, in principle, function perfectly in theory, but the conditions required for its implementation can rarely be encountered in practice.
5. The main reasons that influence emerging inventory management problems are the reliability of suppliers to deliver the ordered goods on time, as well as the uncertainty and lack of attention to inventory management reflected in the links between order quantities and realistic demands – high quantities of illiquid inventory (dead stock).

The process thus highlighted can be industrialized via the development of software allowing a certain flexibility and rigor in the management of multi-product stocks. This software can be interfaced with a finance ERP (Enterprise Resource Planning) for a better management of companies' cash flow. Furthermore, additional functionalities can also be added to particularly take into account the seasonality of certain products and other highly volatile and/or unsteady demand. Finally, multi-sectoral case studies within various geographic contexts can be of definite contribution to emphasize the importance of the proposed model developed in this research.

Appendix: Questionnaire

Part I

1. Please evaluate the statements provided.

	Strongly Disagree	Disagree	Neither Agree nor	Agree	Strongly Agree
The company's inventory management has a significant impact on the company's profitability					
Sufficient attention is paid to inventory management in the company					

2. Please assess the main issues that should lead to a review of the inventory management policy.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The need to avoid stock shortages and improve customer service					
The need to increase the return on investment					
The need to reduce prices and increase					

flexibility					
Purchasing from foreign suppliers prolongs delivery times and increases uncertainty					
Uncertain demand for short-lived goods makes forecasting difficult					
Too much stock available					
Freezing of working capital in fixed stocks					

3. Please evaluate how much attention is paid to inventory management in your company. From 1 - "No attention at all" to 10 - "Very much attention".

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
The level of attention paid to inventory management in your company										

4. Please indicate how long your company has unsold inventory due to incorrectly planned sales?

- 1-30 day;
- 31-60 day;
- 61-90 day;
- 91-180 day;
- 180 d. And more

5. Please estimate which part of the inventory management is causing the most problems in your company.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Information order preparation and transmission					
Order acceptance and inclusion in the performance accounting system					
Execution of the order					
Order transportation					
Choice of storage method					

6. Please evaluate what factors affect inventory management in your company.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
It is difficult to determine future demand					
There is no competent person specifically responsible for stock					

management					
The company does not have a system in place to manage all data on the sales history of the product, to respond more quickly to fluctuations in demand and to identify the factors affecting it.					
There is a regular encounter with the supplier's inability to deliver the item, which requires ordering larger stocks					
Mandatory minimum order quantity from suppliers too high.					

7. Please indicate on the basis of which criteria the order size is formed in your company. ***There are several options to choose from.***

- Projected future sales;
- Storage costs;
- Order costs, document handling costs, product receipt costs, storage costs, order transfer costs;
- Transportation costs;
- Batch size.

8. Please indicate on the basis of which mathematical calculations the forecast of sales of the product for the next period is made in your company.

- Deferred sales are planned based on the sales of the previous period, taking into account the percentage change in sales, between certain months of the previous period;
- Deferred sales are calculated by smoothing the sales of the previous period by a constant from 0 to 1, which shows the error of the last forecasted sales and actual past sales;
- Deferred sales are determined based on the sales of the previous period and a particular factor, time or price that has the greatest impact;
- Deferred sales are determined based on deferred sales and more than one factor - price, time, competitors, etc.

9. Please indicate how often reserve stocks are ordered - additional quantity of goods for unplanned sales in your company.

- Always;
- Sometimes;
- Never.

10. Please indicate what percentage of the current stock size is the reserve stock in your company.

- 0 - 10 percent;
- 11 - 20 percent;
- 21 - 25 percent;
- 26 - 30 percent;
- 31 - 45 percent;
- + 45 percent.

11. Please indicate which inventory management model (system) you use in your company. There are several options to choose from.

- ABC inventory management system
- Economical order quantity model
- Fixed inventory ordering model (system)
- Fixed period and time order model (system)
- We do not apply

12. The number of people working in your company:

- to 10
- From 10 to 50
- From 50 to 250
- >250

13. Turnover of your company?

- 1 - 10 million euro
- 11 - 40 million euro
- 41 -100 million euro
- 100 million euros and more

14. Please indicate the field of activity of the company.

Part II

Thank you very much for agreeing to participate in the survey. The purpose of this interview is to identify the main inventory management problems faced by Lithuanian distribution companies. To identify the possibilities of solving these problems, and to analyze the advantages and disadvantages of the inventory management methods used in distribution companies. You are also provided with an inventory management model in case of uncertainty. Please rate it and answer the questions below.

1. What are the main inventory management problems of Lithuanian distribution companies?
2. Please indicate, in your opinion, the reasons why companies face inventory management problems?
3. Please indicate whether, in your opinion, Lithuanian distribution companies pay sufficient attention to inventory management? Justify your answer.
4. Please indicate what are the main factors influencing effective inventory management in the company? Justify your answer.
5. Please indicate, in your opinion, on the basis of which criteria should the stock size be formed?
6. Please indicate, in your opinion, on the basis of which mathematical calculations should the forecast of sales of goods for the next period be made?
7. Please express your opinion on the application of the Fixed Period and Time Ordering System in the distribution company. Indicate its advantages and disadvantages in the case of distribution companies.
8. Please comment on the determination of the Stock Requirement using the ABC method. Indicate its advantages and disadvantages in the case of distribution companies.
9. Please comment on the Economy Order Size Model. Indicate its advantages and disadvantages in the case of distribution companies.
10. Please comment on the integration of the principles of the different models in order to create a unique model for the efficient management of stocks in distribution companies.

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