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Development of Inventory Management Policy for Distributor Company LLC "TH Megapolis"

Final qualification paper of
a 4th year bachelor's program student,
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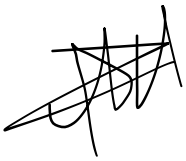

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INTRODUCTION

Globalization has a major impact on inventory management. On the one hand, it provides companies with access to international markets and the opportunity to expand their business. On the other hand, it increases competition and requires companies to be more efficient, including effective inventory management.

The economic sanctions imposed on Russia by Western countries create additional difficulties for doing business, including managing inventory. Effective inventory management can help companies navigate these challenges, streamline operations, and improve competitiveness.

From a practical point of view, the development of an inventory management policy, that takes into account good practices, will allow the enterprise to optimize its operations and improve competitiveness.

The purpose of the study is to develop recommendations for improving the inventory management of TH Megapolis LLC.

To achieve this goal, the following objectives have been formulated, which can be solved in this work:

- to analyze the current inventory management policy in TH Megapolis LLC.
- on the basis of the analysis, identify the advantages and disadvantages of the existing inventory management system, formulate objective requirements for the inventory management system.
- to study modern methods of inventory management, to select appropriate methods for TH Megapolis LLC
- to identify practices of inventory management.
- to propose measures to improve inventory management in TH Megapolis LLC.

Object of research: TH Megapolis LLC.

The subject of the research is the inventory management policy of TH Megapolis LLC.

Management problem: TH Megapolis LLC is a large wholesale and retail trade enterprise that faces the problem of effective inventory management in the context of instability within the international market. The company actively cooperates with foreign suppliers from the CIS countries, Turkey, China, India and Southeast Asia. It is necessary to develop a method for inventory management that will take into account the specifics of international business.

The following methods are used in the work:

1. Document analysis: the method involves the study and analysis of documents of TH Megapolis LLC, which contain information about the current inventory management policy. With

the help of this method, it will be established exactly how inventory management is currently carried out in the company, as well as problem aspects and areas for improvement will be identified. This method is used to accomplish the second task of the work plan.

2. Comparative analysis will be applied in the course of comparing international practices of inventory management, as well as in the course of researching their similarities or differences. In particular, the use of comparative analysis will make it possible to determine what methods and approaches are used in other countries and companies, and how they can be applied in the context of TH Megapolis LLC. This method will be used to accomplish the third task of the work plan.

3. Method of data structuring and analysis – includes the collection, organization and analysis of data obtained in the course of research, statistical analysis of data, use of data processing software, etc.

These methods will help to achieve the goal of the study and to fulfill all the tasks specified in the work plan. They will also help to gather the necessary data and information that will be used in the work.

In addition to the already mentioned methods, the following general scientific methods are used in the work:

1. A systematic approach implies the consideration of the object of research as a system consisting of many interrelated elements. In the context of this study, the systematic approach allows us to consider the process of inventory management in TH Megapolis LLC in the context of a broader system - international business, and also makes it possible to take into account all important factors affecting inventory management and develop a more effective method.

2. Analytical methods (analysis and synthesis). Analysis is the process of dividing the whole into its component parts in order to better understand its structure. Synthesis is the process of combining individual elements into a whole to understand the system as a whole. In the context of this work, the analysis is used to study certain aspects of inventory management in TH Megapolis LLC, and the synthesis is used to combine the obtained data and conclusions into a single method for inventory management.

3. Deductive and inductive methods. The deductive method starts with general principles and consists of drawing specific conclusions, while the inductive method begins with specific observations and consists of forming general conclusions. In this study, these methods will be used together: the deductive method will be used to apply the general principles of inventory management to a specific situation in TH Megapolis LLC, and the inductive method will be used to form general conclusions based on the analysis of specific data.

The use of all these methods made it possible to conduct an in-depth and comprehensive study, take into account all important aspects and factors, and develop an effective and reasonable method for inventory management.

Research tools: study and interpretation of scientific and journalistic articles and Internet resources, structuring and analysis of the data obtained.

Sources of primary information: documents of TH Megapolis LLC on the current inventory management policy.

Sources of secondary information: Internet resources, scientific and journalistic articles, statistical data, competitor research, analytical reviews of inventory management systems.

This work consists of an introduction, three chapters, a conclusion, a list of references and appendices.

The content of the chapters is determined by the objectives and logic of the study.

The first chapter provides a detailed description of the company, including its structure, main economic indicators and features of the organization of work. An analysis of existing methods and approaches to inventory management in the company is carried out, the effectiveness of the current system is assessed, and problems and shortcomings are identified. The approaches to inventory management used in TH Megapolis LLC are compared with international practices. The purpose of this comparison is to determine how effectively the company is using modern inventory management techniques and what improvements can be implemented.

The second chapter reviews scientific research and publications related to inventory management in order to determine the current state of knowledge in the field and to identify gaps that may be filled by the study. International inventory management practices are analyzed to understand what approaches and techniques are used internationally, and how they can be applied in the context of the organization under study. Based on a theory and analysis of international practices, requirements for an inventory management policy are formulated. These requirements define what an inventory management system must do to be effective and meet the needs of the organization.

In the third chapter, the directions for improving inventory management, taking into account international practices for TH Megapolis LLC, are proposed. Specific steps and strategies for the implementation of a new inventory management policy in the company are proposed. An analysis of the economic benefits of using the new method is carried out.

In conclusion, the findings for all sections of the study are summarized.

CHAPTER 1 CHARACTERISTICS OF MEGAPOLIS TRADING HOUSE LLC AND THE EXISTING INVENTORY MANAGEMENT SYSTEM

1.1 Organizational and economic characteristics of TH Megapolis LLC

TH Megapolis LLC, registered on November 21, 2002, is an operating legal entity with an authorized capital of 10 thousand rubles. The company is managed by General Director Mikhail Borisovich Dreizin and has one founder.

TH Megapolis LLC is part of the Megapolis Group of Companies, which has two organizations:

1. TH Megapolis LLC (OGRN 1027807992475, INN/KPP 7816198943/781601001);

2. Megapolis Logistics Company LLC (OGRN 1057812251276, INN/KPP 7816371860/781601001).

In this paper, only TH Megapolis LLC (i.e., not the Group of Companies) is considered, so individual elements of inventory management will not be considered, since the functions of managing these elements actually lie with another organization.

TH Megapolis LLC is a legal entity, acts in accordance with the Charter, has separate property under economic management, an independent balance sheet, checking, foreign currency and other accounts in banks, a round seal, a stamp and forms with its name, a website, e-mail, etc.

The legal address of the company is located at the address: 196626, St. Petersburg, Shushary village, Moskovskoye highway, 161, building 10, letter B. To communicate with customers and partners, the company uses the address in St. Petersburg, Salova Street, 72, letter A, room 14 N.

The company also actively uses digital channels to interact with its customers and partners.

In accordance with the Charter, the activities of TH Megapolis LLC are presented in Table 1.

Table 1 – Types of activities of TH Megapolis LLC

OKVED code	Activities
	Principal
46.36	Wholesale trade in sugar, chocolate and sugar confectionery
	More
16.24	Production of wooden containers
46.21.11	Wholesale trade in grain
46.34.23	Wholesale of beer
46.36.3	Wholesale of flour confectionery
46.37	Wholesale of coffee, tea, cocoa, and spices
46.38.22	Wholesale of pet food
46.46.2	Wholesale trade in medical products
46.73	Wholesale trade in timber, building materials and sanitary equipment
46.90	Wholesale, non-specialized,
47.24.2	Retail sale of confectionery products in specialized stores
52.10	Warehousing and storage activities
52.24	Cargo Handling
52.29	Other supporting activities related to transport
73.1	Advertising activities
73.20	Market research and public opinion research
74.20	Photography activities
74.30	Translation and interpretation activities
82.92	Packaging Activities

TH Megapolis LLC provides customers with a wide range of various payment methods, including the ability to pay in cash upon receipt of goods from the courier, payment using bank cards or bank transfers, as well as the option of using various electronic payment systems. In addition, it is possible to pay by postal orders and other methods.

The main technical and economic indicators of TH Megapolis LLC are calculated on the basis of the balance sheet (Appendix 1) and the income statement (Appendix 2). The main indicators of the company's activities are presented in Table 2.

Table 2 – Key performance indicators of TH Megapolis LLC for 2021-2023

Indicator name	2021	2022	2023	Changes				Changes 2023 to 2021	
				2022 to 2021		2023 to 2022			
				t.r.	%	t.r.	%	t.r.	%
Revenue (excl. VAT)	4222688	5031325	5289913	808637	119,15	258588	105,14	1067225	125,27
Production cost	3601820	4410418	4547151	808598	122,45	136733	103,1	945331	126,25
Net value	4048780	4904769	5096267	855989	121,14	191498	103,9	1047487	125,87
Average annual cost of fixed assets	135290	224034	151323	88744	165,6	-72711	67,54	16033	111,85
Number of employees	296	306	302	10	103,38	-4	98,69	6	102,03
Wage fund	193584	206733,6	216715,2	13149,6	106,79	9981,6	104,83	23131,2	111,95
Profits from sales	173908	126556	193646	-47352	72,77	67090	153,01	19738	111,35
Profitability of products, %	4,3	2,58	3,8	-1,72	60	1,22	147,29	-0,5	88,37
Return on sales, %	4,12	2,52	3,66	-1,6	61,17	1,14	145,24	-0,46	88,83
Labor productivity	14265,84	16442,24	17516,27	2176,4	115,26	1074,03	106,53	3250,43	122,78
Fixed asset turnover	31,21	22,46	34,96	-8,75	71,96	12,5	155,65	3,75	112,02
Average monthly salary	54,5	56,3	59,8	1,8	103,3	3,5	106,22	5,3	109,72
Average annual value of working capital balances	1407295	1050934	924636	-356361	74,68	-126298	87,98	-482659	65,7
Cost per ruble of products sold	95,88	97,48	96,34	1,60	101,67	-1,15	98,83	0,46	100,48
Inventory turnover, turnovers per year	5,87	9,21	12,46	3,34	156,9	3,25	135,29	6,59	112,27
Days in inventory, days	62,18	39,63	29,29	-22,55	63,73	-10,34	73,91	-32,89	-52,89

TH Megapolis LLC has seen a steady increase in sales revenue over the past three years. In 2021, this figure amounted to 4,222,688 thousand rubles, in 2022 it increased to 5,031,325 thousand rubles, and in 2023 it reached 5,289,913 thousand rubles. For the period under review (2021-2023), the total revenue growth amounted to 25.27%, which is equivalent to 1,067,225 thousand rubles.

A similar trend is observed in the indicators of the full cost of production. Over the specified period, the total cost of sales increased by 25.87%, which in monetary terms amounts to 1,047,487 thousand rubles. Such growth may also indicate the strengthening of the company's position in the market and the successful implementation of strategies to optimize production processes and marketing.

A comprehensive analysis of the financial performance of TH Megapolis LLC over the past three years demonstrates the sustainable development and growth of the company's economic efficiency, which creates the prerequisites for further successful operation and expansion in the market.

The dynamics of the average annual cost of fixed assets tends to grow. In 2022, the average annual cost of fixed assets increased by 65.6% (by 88744 thousand rubles), and in 2023 it decreased by 32.46% (by 72711 thousand rubles).

In 2022, sales profit decreased by 27.23% (by 47352 thousand rubles), and in 2023 it increased by 53.01% (by 67090 thousand rubles). In total, during 2021-2023, sales profit increased by 11.35%, or 19738 thousand rubles.

In 2021-2023, the profitability of core activities is 4.3, 2.58 and 3.8%, respectively. In 2022, the profitability of operating activities decreased by 1.72%, and in 2023 it increased by 1.

In total, during 2021-2023, the return on sales decreased by 0.46%.

Labor productivity reached its highest value in 2023 and its lowest in 2021. Thus, the dynamics of labor productivity is characterized by steady growth throughout the entire period 2021-2023, for the last two years in a row.

The inventory turnover ratio is the ratio of the net value to the average annual value of inventories, including VAT on purchased values:

– in 2021: 4048780 / [0,5 × (741312 + 5011+631918+383)] = 5,87 turnovers;

– in 2022: 4904769 / [0,5 × (631918 + 383+432795+383)] = 9,21 turnovers;

– in 2023: 5096267 / [0,5 × (432795 + 383+384600+383)] = 12,46 turnovers.

According to the results of the calculations, in 2021-2023, the inventory turnover ratio takes the values of 5.87, 9.21 and 12.46 turnovers per year, respectively. The dynamics of the inventory turnover ratio tends to increase. In 2022, the inventory turnover ratio increased by 56.9% (by 3.34 turnovers per year), and in 2023 - by another 35.29% (by 3.25 turnovers per year). In total, during 2021-2023, the inventory turnover ratio increased by 112.27%, or 6.59 turnovers per year.

Inventory turnover is the ratio of the number of days in a period (365) to the inventory turnover ratio:

– in 2021: 365 / 5,87 = 62,18 days;

– in 2022: 365 / 9,21 = 39,63 days;

– in 2023: 365 / 12,46 = 29,29 days.

Thus, in TH Megapolis LLC, the values of the inventory turnover period are: 62.18 days in 2021, 39.63 days in 2022 and 29.29 days in 2023. The inventory turnover period reached its highest value in 2021, and the lowest in 2023. In 2022, the inventory turnover period decreased by 36.27% (by 22.55 days), and in 2023 - by another 26.09% (by 10.34 days). In total, during 2021-2023, the inventory turnover period decreased by 52.89%, or 32.89 days.

Since a meaningful analysis of the company's economic indicators is not related to the topic of this work, all these indicators are presented in the table of Appendix 3.

The company's economic and financial performance shows that over the past three years, the company has significantly expanded the scope of its activities, improved its economic performance, strengthened its financial stability and solvency, and is a responsible employer and cares about the well-being of its employees.

The forms of organization of the trading process in TH Megapolis LLC are characterized by a variety and are aimed at improving the efficiency of commercial activities and meeting the needs of customers. The main forms of organization of the trading process include:

– retail sales;

– e-commerce;

– distribution;

– catalog trading.

Retail sales are carried out through the company's physical outlets, such as retail stores, where customers have the opportunity to familiarize themselves with the range of goods, get advice from specialists and make a purchase on the spot.

Online trading is a form of organizing the trading process through Internet platforms and electronic resources, where customers can view goods, get acquainted with their characteristics, place an order and pay for a purchase online.

Distribution involves the supply of furniture through distribution centers and partner organizations that distribute products regionally and locally, ensuring a wide reach of customers and meeting demand.

Catalog trading allows customers to choose products from special catalogs with detailed descriptions and images, which simplifies the process of choosing and ordering the right products.

These forms of organization of the trade process contribute to the satisfaction of various needs of customers, providing convenience and variety of choice when buying goods in TH Megapolis LLC.

1.2 Analysis of the current inventory management policy at TH Megapolis LLC

To study the existing inventory management system in TH Megapolis LLC, a semi-structured interview was conducted with the general director of the company, with the head of the sales department, as well as with warehouse employees. In addition, the study was based on the author's own observations made during the visit to the enterprise.

In order to ensure an uninterrupted trading process, the supply of goods and for the rational use of warehouses, TH Megapolis LLC has formed its own inventory management policy.

The formation of stocks of goods in the warehouses of a trading enterprise occurs for the following reasons:

– possible changes in sales plans, both upward and downward;
– fluctuations in demand for goods, both upward and downward;
– risks of delays in the supply of goods from manufacturers;
– identification of low-quality or defective goods.

The inventory management policy of TH Megapolis LLC contains the following provisions:

– to classify inventories of goods according to the "ABC" method according to their value;
– to classify inventories of goods according to the "XYZ" method in accordance with the deviation of the value of the indicator of their actual sale from the standard values of this indicator;
– to form a management system for each group of stocks of goods;
– to formulate control parameters for each of the groups of reserves, in particular: the size of the safety stock; interval between orders; the maximum amount of stock; the optimal amount of stock, and so on.

Let's explain in more detail the features of managing each group of stocks of goods.

The formation of a management system for each group of stocks of goods in TH Megapolis LLC includes the development of individualized strategies and management parameters for various categories of goods classified according to the "ABC" and "XYZ" methods. This allows you to effectively manage inventory, taking into account its importance and predictability of demand. Below is a more detailed explanation of this process.

1. Classification of reserves according to the "ABC" method. The "ABC" method divides inventories into three categories:

– Category A: high-cost goods that make up a small proportion of the total stock but a significant part of the total cost;

– Category B: goods of medium value and importance;

– Category C: low-cost goods that make up a large part of the inventory but a small fraction of the cost.

2. Classification of reserves according to the "XYZ" method. The XYZ method assesses the predictability of the consumption of goods:

– Category X: Products with constant and predictable demand;

– Category Y: goods with moderate predictability of demand, often dependent on seasonality;

– Category Z: goods with irregular and difficult to predict demand.

3. Formation of a management system for each group of stocks of goods.

AX (High-Cost Products with Predictable Demand) category:

– The size of the safety stock: minimal, since the demand is predictable;

– Order interval: short to minimize storage costs;

– maximum stock value: moderate to avoid excess costs;

– Optimal Inventory Value: Calculated based on an analysis of demand and supply.

AY category (high-cost goods with moderate predictability of demand):

– Safety stock: moderate to cover fluctuations in demand;

– Interval between orders: medium to balance between order frequency and costs;

– maximum stock value: moderate, seasonally adjusted;

– Optimal stock value: determined taking into account seasonal forecasts and sales data.

Category AZ (high-cost goods with unpredictable demand):

– Safety Stock Size: High to avoid shortages;

– Interval between orders: short to respond to unexpected changes in demand;

– maximum stock value: high, taking into account possible interruptions in supplies;

– Optimal stock value: Determined based on a risk and demand analysis.

BX Category (Mid-Cost Goods with Predictable Demand):

– Safety stock size: low;

– Order interval: medium;

– maximum stock value: moderate;

– Optimal stock value: calculated taking into account stable demand.

Category BY (medium-cost goods with moderate predictability of demand):

– Safety stock size: medium;

– Interval between orders: moderate;

– maximum stock value: average;

– Optimal stock value: Determined based on seasonal data.

Category BZ (medium-cost goods with unpredictable demand):

– Safety stock size: high;

– Interval between orders: short;

– maximum stock value: high;

– Optimal stock value: determined taking into account the risk and data of previous periods.

CX category (low-cost goods with predictable demand):

– Amount of safety stock: minimum;

– Order interval: long;

– Maximum stock value: low;

– Optimal stock value: Determined on the basis of minimum costs.

CY category (low-cost goods with moderate predictability of demand):

– Safety stock size: low;

– Order interval: medium;

– maximum stock value: average;

– Optimal stock value: determined taking into account fluctuations in demand.

Category CZ (low-cost goods with unpredictable demand):

– Safety stock size: medium;

– Order interval: medium;

– maximum stock value: high;

– Optimal stock value: calculated taking into account the risk of shortage and data from previous periods.

ABC analysis of the stock of goods allows you to assess and control the most expensive part of the assortment by optimizing the level of balance.

Group "A" includes goods that make up 80% of the total cost of goods.

Group "B" includes goods that make up 15% of the total cost of goods (90-95% cumulative together with group "A").

Group "C" includes goods that make up the remaining 5% of the total cost of goods.

The categories can be expanded if necessary, as well as the percentage of the cost of each category. The criterion for increasing the number of categories is the homogeneity of costs, amounts, shares.

ABC analysis of the cost of goods balances as a method of decision-making is used taking into account the analysis data for previous periods from the beginning of the reporting period. ABC analysis of the cost of the remaining goods is carried out by the sales manager based on data from the accounting system.

The ABC analysis of the commodity groups of TH Megapolis LLC is presented in Table 3.

Table 3 – ABC-analysis of commodity groups

Product group	Share in turnover in descending order, %	Share in cumulative turnover, %	Group
Grain	26,4	26,4	A
Flour	23,6	50	A
Confectionery	15,2	65,2	A

Sugar	10,1	75,3	A
Construction	9,7	85	B
Medical Devices	7,8	92,8	B
Other Products	7,2	100	C

The XYZ-analysis of the commodity groups of TH Megapolis LLC is presented in Table 4.

Table 4 – XYZ analysis of commodity groups

Product group	Coefficient of variation, %	Group
Grain	3	X
Flour	4	X
Confectionery	7	Y
Sugar	10	Y
Construction	17	Y
Medical Devices	23	Z
Other Products	26	Z

The distribution of goods by groups X, Y and Z is based on deviations of the actual sales volume from the norm.

Group "X" includes items with a deviation of 0-5%.

Group "Y" includes items with a deviation of 5-20%.

Group "Z" includes items with a deviation of >20%.

When combining ABC and XYZ analyses, we get 9 groups of goods, and each of the groups has two characteristics: the cost of stocks and the accuracy of forecasting the need for them. The results of the combined analysis are presented in Table 5.

Table 5 – Combination of ABC- and XYZ-analysis

Classification categories		Increasing unevenness of product leaving the warehouse		
		X	Y	Z
Increase in sales	A	AX	AY	AZ
	B	BX	BY	BZ
	C	CX	CY	CZ

Based on the overall grouping and cost of goods, it is advisable to combine some items, namely AX and BX. Accordingly, the same inventory management system will be applied to the above groups.

Thus, the inventory management system is selected for a pair of groups AX and BX, which is characterized by stable demand, goods should be constantly available, but not in excess, since the goods are expensive and demand is well predicted.

The order volume of the received system is fixed, that is, each of the orders has a constant volume in each of the planned periods, and a constant stock standard.

Assortment planning in TH Megapolis LLC is carried out on the basis of the current demand formed by the system, taking into account the balances in warehouses and the current market situation (weekly plan, demand rate).

The main parameters that determine the assortment in TH Megapolis LLC are as follows:

1. Minimum required margin (warranty - ensuring uninterrupted operation of the enterprise).

2. Minimum lot size.

3. Minimum order quantity.

4. Transport restrictions.

5. Warehouse volumes.

6. Shelf life.

7. Deadline for placing a purchase order.

8. Delivery Time.

The logistics department is responsible for the sufficiency of inventory. This department also performs the following functions:

- Monitors the total volume of inventory, coverage of needs on a monthly basis.
- daily, weekly and monthly, the logistics specialist plans requests for the supply of goods, adjusts requests for items planned;
- The specialist of the planning department is responsible for the timely placement of purchase orders with the supplier within the period specified in the contract.

In the process of planning the required volume of inventory, special attention is paid to:

- assortment, quantity and quality of goods;
- packaging materials;
- goods of imported origin.

All responsibility for full information support, adjustment, planning, establishment and approval of the consumption rate of goods lies with the logistics department. A full flow of information on changes in the current situation with the actual consumption of goods is also provided by the logistics department.

In each case, the company analyzes the reasons for both the lack of balances and excess stock. In any case, the company is taking measures to avoid the recurrence of similar situations in the future. In order to prevent the collapse of the trading process, the company's specialists periodically analyze the compliance of the available stocks in the warehouse with the current needs for them.

There are the following criteria for making a decision on the formation of requests for the supply of goods:

– the demand for them;
– the balance of this type of goods in warehouses;
– planned and confirmed deliveries by customers.

Information about the daily indicators of the enterprise, such as the volume of stock of each type, goes to a specialized inventory management program (the 1C Trade Management software package is used). Every day, this program receives data on the balance in each warehouse for each item.

“1C Trade Management 8” automates:

– sales management (including wholesale, retail and commission trade);
– supply management;
– sales and procurement planning;
– inventory management;
– management of customer orders;
– customer relationship management;
– analysis of the company's turnover;
– price analysis and pricing policy management;
– monitoring and analysis of the effectiveness of trading activities.

"1C Trade Management 8" increases the efficiency of the enterprise by automating routine operations, by keeping records in real time, by quickly and conveniently preparing information for decision-making at different levels.

When changing the scale, approaches to management or organization of work at the enterprise, restructuring the system does not require large costs. This is achieved by building business solutions on a powerful modern technological platform.

The 1C Trade Management 8 program provides automation of key business processes of the enterprise, such as sales management, including wholesale, retail and commission trade, as well as supply management and sales and procurement planning. It allows you to effectively control inventory and manage customer orders, improving customer interaction and fostering strong business relationships.

The system also provides tools for analyzing the company's turnover, researching price trends and managing pricing policy, which helps to make informed strategic decisions. Monitoring and analysis of trading performance becomes much easier due to the integration of all data into a single system.

Automation offered by 1C Trade Management 8 significantly increases the productivity of the enterprise. It eliminates routine operations by providing real-time accounting, which allows you to quickly and conveniently prepare information for making management decisions at various levels.

The program is highly flexible, which makes it easy to adapt it to changing business scales, new management approaches or organizational changes. This is possible thanks to the use of a powerful modern technological platform that minimizes the cost of system restructuring and ensures the long-term sustainability of business decisions.

Thus, the implementation of 1C Trade Management 8 contributes to improving the overall efficiency of the enterprise, improving the quality of management, and strengthening competitive positions in the market.

1C Trade Management 8 has the following functionality:

– construction of various schemes for the formation of retail prices and discounts;
– formation of retail prices taking into account purchase prices and profit margins;
– control over employees' compliance with the established pricing policy;
– storage of information about the prices of competitors and suppliers;
– comparison of the company's selling prices with the prices of suppliers and competitors.

The main disadvantage of 1C Trade Management 8 is primitive forecasting, that is, when determining the size of the order, it is assumed that the demand will be equal to the sales of the previous period.

At the moment of development of TH Megapolis LLC, there is a need to use new software that is more adapted to the company's work system, to the peculiarities of commodity items and able to respond more flexibly and quickly to changing market conditions.

Thus, the managers of the logistics department directly perform the functions of managing the company's inventory and controlling the level of stocks (Table 6).

Table 6 – Inventory management functions on the part of the logistics department

Functions	Characteristics
Planning the optimal amount of stocks	The optimal value is determined separately for each type of goods
Validity of safety stock standards	The amount of safety stock is also determined separately for each type of goods
Periodic revaluation of the volume, value and life of inventories	The period can be a week, a month, a quarter, a year, and so on, depending on the range of goods
Timely placement of requests for replenishment of warehouses with goods	Orders are also placed for all types of goods

Reasonable assessment of the volume and value of written-off goods	Write-off of goods is carried out when their expiration date, damage during transportation and storage, etc
Periodic fulfillment of the company's turnover goals	The period can be a week, a month, a quarter, a year, and so on, depending on the range of goods
Timely informing responsible specialists about the adjustment of standard consumption values of a particular product	These standards are developed (and subsequently specified) by the management services of the enterprise

The most capacious logistical and at the same time financial indicator characterizing the effectiveness of investments in inventories is the profitability of inventories.

Let's analyze this indicator in the inventory management system of TH Megapolis LLC using the example of AX group products (according to ABC/XYZ analysis). The period under consideration is 2023. The results of the calculations are presented in Table 7

Table 7 – Indicators of economic efficiency of inventory management for 2023

№	Product name	Sales volume, rub.	Inventory, rub.	ITR	Collected markup, rub.	PR	Return on inventory
1	High-grade wheat flour	6918660	7658500	0,90	1576260	0,23	0,21
2	Organic rye grains	3949308	4197600	0,94	276408	0,07	0,07
3	Whole-grain bulgur	888520	1350000	0,66	38020	0,04	0,03
4	Buckwheat flour	774676	1226400	0,63	290836	0,38	0,24
5	Corn kernel for popcorn	534750	539400	0,99	138900	0,26	0,26
6	Quinoa flour	459936	590000	0,78	38046	0,08	0,06
7	Oat grains	968000	1320000	0,73	338000	0,35	0,26
8	Rice flour	269100	308100	0,87	86610	0,32	0,28
9	White rice	234000	315000	0,74	87000	0,37	0,28

Analyzing the results obtained, it can be stated:

1) low inventory turnover ratio (ITR) for some goods is due to excess stocks in the warehouse. Therefore, it is necessary to take measures to calculate the optimal level of reserves in order to improve the return on of inventory.

2) low profitability ratio (PR) of some goods is due to the small value of the final margin, which arises as a result of unreasonably large purchase sizes and high associated costs. Consequently, it is also necessary to reduce the costs associated with inventories.

The main problem can be singled out - the company, when planning inventories, focuses on easily predictable and expensive inventories (flour and grain). In this case, with a decrease in the volume of production, freezing of funds in stocks may occur, caused by their excess. The lack of any flexibility in inventory planning can adversely affect the rhythm of production and the

structure of working capital. This can provoke problems during the trading process due to the lack of the necessary goods.

Summarizing the above, several important conclusions can be drawn.

The inventory management system in TH Megapolis LLC is based on the use of 1C Trade Management 8 software, which operates on the basis of Wilson's formula. This system includes several key aspects aimed at organizing the trading process, ensuring the smooth functioning of the enterprise and meeting the needs of customers.

The accumulation of stocks in warehouses is due to several reasons. Firstly, there are possible changes in sales plans and fluctuations in demand for goods, which requires flexibility in inventory management. Secondly, the risks of delays in deliveries from manufacturers and the identification of low-quality goods also affect inventory levels, requiring the creation of reserves to minimize negative consequences.

In inventory management, the "ABC" classification method by the cost of goods and the "XYZ" method are used, which takes into account the deviations of actual sales from standard values. These methods allow you to efficiently allocate resources and manage different groups of goods, taking into account their importance and predictability of demand.

For each group of goods, control parameters are set, including the size of the safety stock, the interval between orders, the maximum and optimal stock value. These parameters ensure balanced inventory management, minimizing the risks of shortages or overstocks of goods.

Assortment planning is based on the analysis of current demand, stock balances and the market situation, which allows the company to quickly respond to changes and maintain an optimal level of inventory. The main parameters that determine the assortment include the minimum required stock, minimum delivery and order batches, transport constraints, warehouse volumes, shelf life and delivery.

The main goal of inventory management is to ensure an uninterrupted supply of goods with minimal storage and purchase costs. However, the current inventory management system at TH Megapolis LLC faces a number of serious shortcomings that hinder the achievement of this goal.

The shortcomings of the current system include limited methods of demand forecasting, lack of dynamic optimization, insufficient automation, and failure to take into account the variety of goods. These problems lead to inefficient inventory management, which negatively affects the overall productivity and profit of the company.

In order to better understand and eliminate these problems, an Ishikawa diagram (cause-and-effect diagram) was compiled, which clearly demonstrates the main reasons for the low efficiency of the inventory management system in TH Megapolis LLC. The fishbone diagram clearly shows the key areas for improvement (Figure 3).

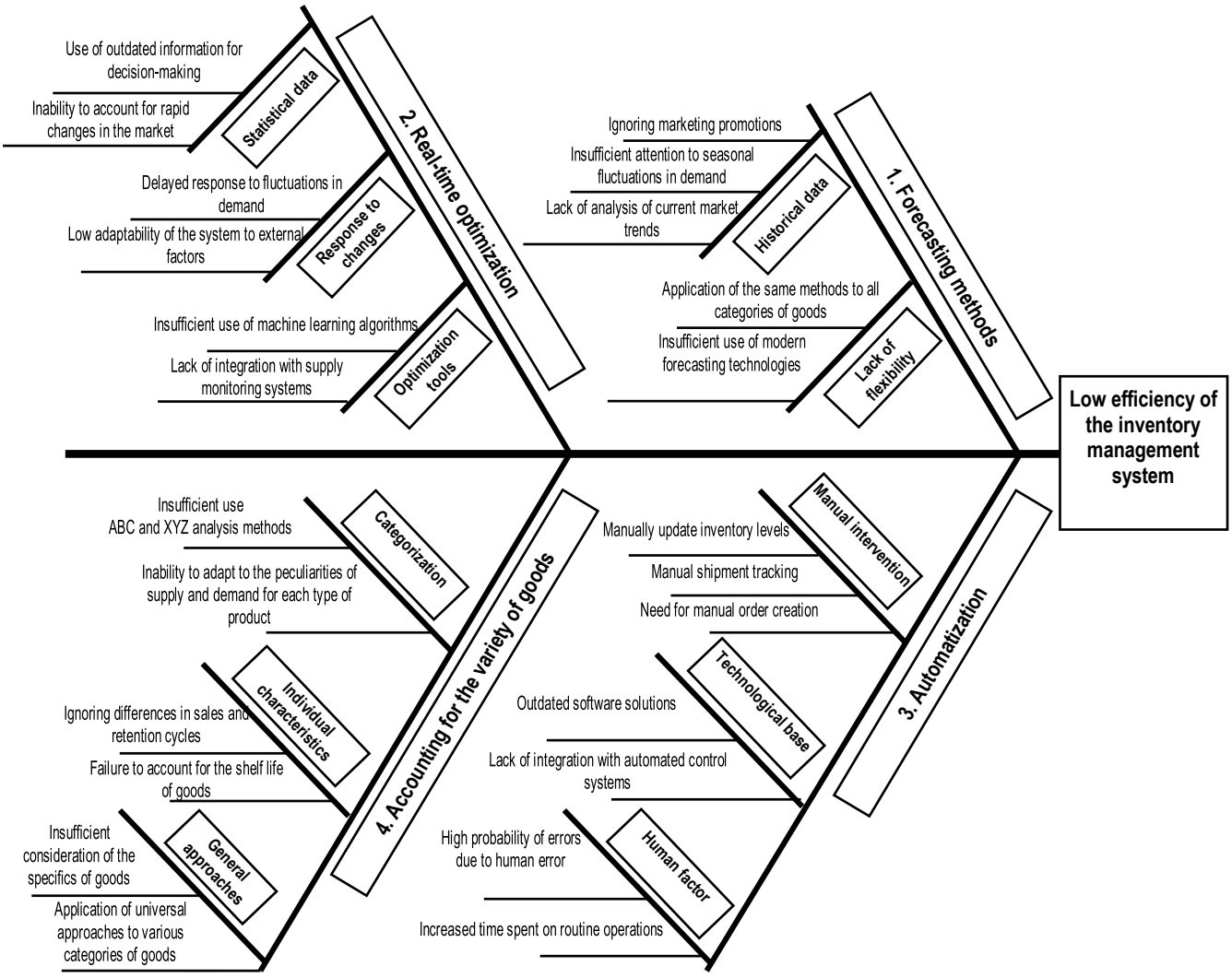

Figure 3 – Cause-and-effect diagram "Low efficiency of the inventory management system"

Thus, it can be said that ehe existing inventory management system has a number of drawbacks. These shortcomings are summarized in Table 8.

Table 1 – Shortcomings of the existing inventory management system

Disadvantages	Characteristic
Limited forecasting methods	The system can estimate demand based on historical data, but it does not always take into account seasonal fluctuations, marketing promotions, and other factors that can affect demand.

Lack of dynamic optimization	The system does not take into account changes in demand and supply in real time. It calculates orders based on static data, which can lead to incorrect decisions in dynamic changes.
Insufficient automation	The system requires manual intervention to generate orders, track deliveries, and update inventory levels
The inventory management system does not take into account the variety of goods	The system does not always take into account this complexity and can only apply general approaches to inventory management, does not take into account the individual characteristics of goods

As Table 8 shows, current inventory management system is limited in forecasting methods, does not always take into account seasonal fluctuations and marketing promotions, which can lead to excess or insufficient inventory. In addition, the system does not provide dynamic optimization, calculating orders based on static data, which reduces its efficiency under changing conditions.

For several days, we have been monitoring the organization of requests in TH Megapolis LLC. In the course of this study, it was revealed that on average, sales departments send about 100 requests for goods to the warehouse per day.

About 5 of them are discarded immediately, as the warehouse system combines them with other similar requests. For example, if a request was received in the morning for 5 bags of flour, and in the evening for 3 more of the same bags of flour, then in the daily report this will be taken into account as "a request for 8 bags of flour has been received". This is done intentionally, for accounting purposes, since 1C is primarily an accounting system.

After this simple arithmetic operation, 95 active orders remain in the system.

With a two-shift operation of the company, this means about 95 / 16 = 5.93 requests per hour, or about 1 request every 10 minutes. This roughly corresponds to the daily unhurried nature of work in the usual mode. Employees of the enterprise are accustomed to this mode of work and take it for granted.

Of these requests, only about 90 are processed on the same day. The remaining 5 requests, as a rule, are either more complex requests that require additional processing and approval, or requests received a few minutes before the warehouse closes. Such requests are processed on the next business day.

The reasons why not all of the requests are processed on the day they are received can be varied. For example, in some cases, this is due to the limitations of current forecasting methods, which do not always adequately take into account seasonal fluctuations, marketing promotions, and other factors that affect demand. It is also noted that there is no dynamic optimization, as a result of which the inventory management system cannot quickly respond to changes in demand and supply in real time. This leads to the fact that orders are calculated based on static data, which does not always correspond to the current situation.

Insufficient automation of the inventory management process requires manual intervention to generate orders and track deliveries, which increases the risk of errors and time-consuming. In addition, the system does not take into account the variety of goods, applying general approaches to inventory management, which is not always effective for different product categories.

1. Overloaded racks. Excess inventory in the warehouse leads to insufficient storage space, which increases the risk of damage to goods due to improper storage. Goods that are inconveniently accessible can be subject to mechanical damage or deformation, which directly affects their quality.

2. Expired shelf life. Improper demand forecasting and inefficient inventory management can lead to an accumulation of goods with an expiring shelf life. This is especially critical for products with a limited shelf life, such as food, medicines, and cosmetic products. The sale of expired products has a negative impact on the company's reputation and the health of consumers.

Thus, the limitations of the existing inventory management system in TH Megapolis LLC create risks for maintaining the required level of product quality. These problems lead to an increase in the number of defective goods, a decrease in their consumer properties and, as a result, to a deterioration in the overall quality of customer service. To solve these problems and improve the quality of service, it is necessary to introduce more modern and automated inventory management systems that can take into account dynamic changes in demand and the specifics of various product categories.

Thus, the existing inventory management system at TH Megapolis LLC needs to be modernized.

To improve the efficiency of inventory management, it is recommended to consider more modern and automated solutions that consider the dynamic changes and variety of goods, which will allow the company to improve inventory management and customer satisfaction.

1.3 Features of inventory management at TH Megapolis LLC

TH Megapolis LLC offers a very wide range of products. The company regularly replenishes the assortment with new categories of goods and connects new manufacturers to cooperation. The catalog of TH Megapolis LLC is updated with new products daily, which allows us to offer the most relevant product for its customers.

TH Megapolis LLC works without intermediaries with all manufacturers, so it can offer customers low prices on the market. In addition, TH Megapolis LLC has four levels of favorable wholesale prices depending on the size of the purchase, as well as a special bonus program.

TH Megapolis LLC uses a traditional approach to inventory management, based on demand forecasting and determining the optimal level of inventory. The Company strives to maintain sufficient inventory levels to ensure continuity of production and minimise the risk of shortages. However, this approach can lead to excess inventory and increased storage costs.

In the context of international practices, many companies are moving towards more flexible and adaptive inventory management models. One such approach is the concept of Just-In-Time (JIT), which involves minimizing inventory through precise planning and coordination of deliveries. This approach allows you to reduce storage costs and reduce the risks associated with the obsolescence of goods.

In addition to the above-mentioned approaches, there are other concepts of inventory management that can be applied in different contexts. For example, the concepts of maximizing, optimizing, and minimizing inventory. These approaches can be adapted depending on the specifics of the business and market requirements.

In general, the approach of TH Megapolis LLC to inventory management is quite effective, but there is potential for improvement through the introduction of new technologies and methods used in international practice.

When compiling the assortment, it is necessary to consider the ratio of individual groups of goods depending on the volume of turnover and the terms of delivery of goods.

Inventory management provides control over the condition of the product, its storage, and the use of components that are involved in its production. This process controls the number of finished products for sale.

A business has certain costs for storing, tracking, and insuring its inventory. Improper inventory systems can create significant financial problems for a business, as improper management leads to overstocking or understocking.

Compiling an "assortment matrix" (or current product range) is one of the priorities of business development managers. What and how much to buy for sale, so that the product does not lie dead weight, is quickly sold and makes a profit.

In logistics, there are many tools to solve this problem, the most effective of them are considered and tested in the Russian market.

The right approach to managing the activities of wholesale enterprises can significantly reduce the financial costs of delivery, storage and promotion of goods. One of the most effective levers to minimize costs is the optimal order of goods.

To correctly determine the optimal volume of the order, it is necessary to control the main data of the enterprise: analytical and statistical. The main parameters that determine the optimal order are:

- the speed of implementation of one order, which is measured in units per year;
- delivery cost (rubles per order);
- price of one order (rubles);
- inventory maintenance costs (the ratio of the cost of storing inventory to its total cost).

There are various models of inventory management, which are adapted depending on the volume of sales and the specifics of the work of a particular trading enterprise. Each model, regardless of its complexity, must answer two key questions: how much and when to order. Accurate answers to these questions allow you to formulate an effective inventory management strategy.

The most effective inventory management models are the optimal order line model and the inventory management model with a fixed time interval between orders.

The optimal order line model involves constant monitoring of inventory levels and regular placement of fixed volume orders. An order is made when the stock level reaches a predetermined minimum, known as the reorder point. This process can be automated, which ensures timely replenishment of inventory. If inventories decrease below a critical level, the company faces a shortage of goods, which negatively affects its reputation and profitability. On the other hand, placing an order prematurely leads to an unreasonable increase in storage costs.

For the optimal batch model to function effectively, it is also necessary to determine the optimal order quantity. This volume is calculated on the basis of statistical data collected over a certain period, usually during the year. By analyzing this data, the company can determine the most suitable order size, which helps to reduce costs and improve inventory management.

The inventory management model with a fixed time interval between orders is based on the principle of regular replenishment of inventory at certain intervals. This approach simplifies planning and management, as orders are placed according to a predetermined schedule, which stabilizes supply processes and minimizes the risks associated with fluctuations in demand and supply in the market.

The Wilson model, also known as the Economic Order Quantity (EOQ), is an effective tool for optimizing not only production inventory, but also finished goods. When using this model, all costs associated with inventory management are divided into two main groups depending on how they change with the size of the lot:

1. Order costs – related to each new batch of inventory and do not depend on the batch size. This category includes the costs of ordering, transportation, as well as administrative costs associated with the procurement process.

2. Holding costs are associated with the storage of goods in the warehouse and depend on the volume of inventory. They include the cost of renting or maintaining storage facilities, insurance, as well as possible losses from obsolescence or damage to goods.

The use of this model contributes to the optimization of batch size with minimal total costs.

To calculate economic order quantity, we use the Wilson Model (EOQ):

$$S_{opt} = \sqrt{\frac{2 * O * C_т}{C_х}}, \quad (1)$$

where S_{opt} – economic order quantity:

O – the size of consumer demand or the volume of turnover;

$C_т$ – ordering costs;

$C_х$ – holding costs.

Traditional methods, based on manual data analysis and the experience of specialists, often cannot cope with the increasing complexity of business processes. In this regard, the introduction of artificial intelligence (AI) into the inventory management system seems to be a promising solution that can increase the efficiency of the company and provide it with competitive advantages.

AI systems can analyze large amounts of heterogeneous data, including historical sales, seasonal fluctuations, marketing campaigns, and macroeconomic indicators, to identify patterns and build accurate demand forecasts.

Based on demand forecasts, AI systems can automatically generate optimal orders for goods, allowing the company to minimize inventory and storage costs, as well as prevent shortages leading to lost sales and customer dissatisfaction.

AI systems can track the shelf life of goods and optimize their placement in the warehouse, which minimizes losses from spoilage, write-offs, and expiration dates. They can also automate routine tasks such as data collection and processing, reporting, and assortment analysis, freeing up employees' time to focus on more strategic tasks.

By forecasting demand more accurately and optimizing inventory levels, AI systems can help a company increase the availability of goods for customers, reduce out-of-stock and reduce waiting times.

The introduction of artificial intelligence into the inventory management system of TH Megapolis LLC has significant potential to increase the efficiency of the company, reduce costs, improve the quality of customer service and ensure competitive advantages in the market.

The implementation of the Just-in-Time (JIT) system in the inventory management system also seems to be a promising solution that can increase the efficiency of the company's work and provide it with a competitive advantage.

JIT allows the company to significantly reduce the cost of storing, transporting and insuring inventory, as well as the costs associated with spoilage and write-off of goods. JIT contributes to faster inventory turnover, which leads to a decrease in the need for working capital and an increase in the profitability of the business.

JIT incentivizes suppliers to tighten product quality control, as any defects can lead to a halt in the production process or disruption in sales, and allows the company to respond quickly to changes in demand and market conditions, as it does not need to incur the cost of storing excess inventory.

In addition to AI and JIT, there are a number of other inventory management methods that can be used in TH Megapolis LLC:

EOQ (economic order quantity) method – this method allows you to determine the optimal order size of goods, which minimizes the total costs associated with the storage and purchase of goods.

Min-Max Inventory Management Method – allows you to maintain two inventory levels for each item: minimum and maximum. When the stock level of an item falls below the minimum level, a replenishment order is made.

MRP (material requirements planning) method – allows you to plan the need for materials and components for the production or sale of goods, taking into account the production plan, stock level and delivery times.

VMI (vendor-managed inventory) method provides the supplier with the ability to independently manage the level of inventory of goods in the company's warehouse.

The above methods can be used to optimize the company's inventory management system, increase its efficiency and reduce costs.

CHAPTER 2 THEORETICAL FOUNDATIONS OF INVENTORY MANAGEMENT IN INTERNATIONAL PRACTICE

2.1 Methods of inventory management

Inventories play a key role in ensuring the stability and continuity of the production process. Effective inventory optimization at enterprises allows you to achieve significant results with minimal costs.

The positive role in the formation of stocks lies in several key aspects:

- the availability of sufficient stocks contributes to increasing the efficiency of the enterprise;
- effective inventory management ensures high quality customer service, meeting their needs in a timely manner and in full;
- stocks insure the enterprise against supply disruptions, creating a buffer for possible delays.

In addition, the availability of stocks protects the company from higher prices for raw materials and components (allowing them to be purchased in advance at lower prices), contributes to savings on warehouse costs and transportation costs.

Stockpiling has a negative aspect, which is the freezing of significant financial resources. Inventory costs are varied and include storage, administration, transportation, production, order processing, and the value of lost sales and frozen assets. In addition, it is necessary to take into account the costs of checking the quality of products, loading and unloading goods.

Thus, inventory management is a complex and multifaceted process that requires careful analysis and control. The main rule of inventory management is that an increase in their volume is justified only as long as the expected savings exceed the costs of maintaining additional stocks and diverting working capital [58, p.77].

Competent inventory management includes not only reducing costs, but also ensuring an uninterrupted supply of production and sales processes. It is important to find a balance between sufficient inventory levels needed to meet demand and minimizing the costs associated with them.

Figure 1 illustrates the inventory management dilemma. As follows from the figure, excess inventories give the enterprise the same negative effect as insufficient ones, so a reasonable balance is needed between ensuring the continuity of production and minimizing the costs associated with inventories. [66, p.250].

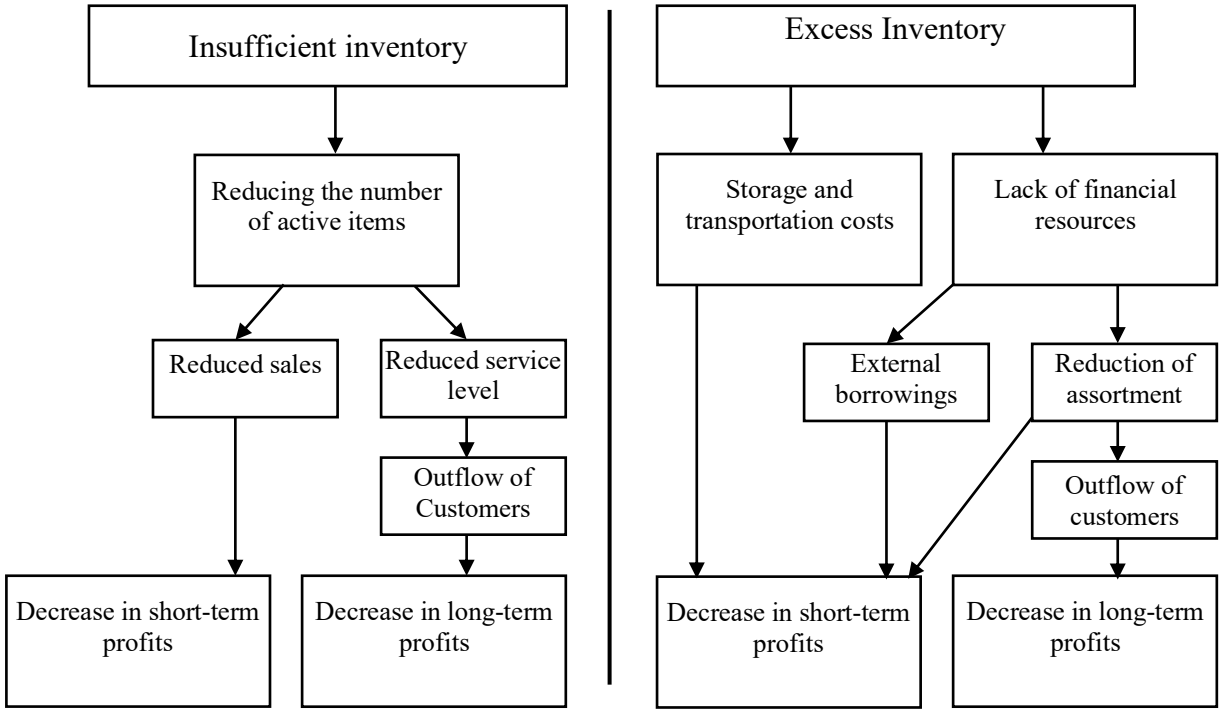

Figure 1 – The Inventory Management Dilemma

The theory of inventory management is quite well developed in scientific literature and is successfully applied in practice. From the point of view of theoretical analysis, the most interesting are scientific studies and publications devoted to the issues of methodology and general understanding of inventory management in modern business.

The first group of scientific literature studied is devoted to the topic of methodology.

The article «Research on the Inventory Management in the Modern Business» (2024), published in January 2024 in the journal "Advances in Economics Management and Political Sciences" (60(1):1-8) [97] provides a comprehensive analysis of modern methods and practices of inventory management in business.

In this study, the authors conduct a detailed review of the current technologies and tools used for inventory management. They explore how different inventory management strategies can impact business performance, including reducing costs, improving customer service, and increasing profits.

The review «Green supply chain quantitative models for sustainable inventory management: A review» (2021) [13] discusses the various quantitative models used in inventory management in the green supply chain. The authors discuss various approaches to green supply chain modeling, including the use of linear programming, dynamic programming, game theory, and other optimization techniques, and consider how these models can be integrated into inventory management systems to improve their sustainability.

A fundamental source of knowledge on inventory management in the context of strategic supply chain management is the chapter "Inventory Management" in the book "Strategic Supply Chain Management" [96] published in 2019. In this chapter, the authors take an in-depth look at key aspects of inventory management, including its role and importance in supply chains, key issues and challenges, and effective management strategies and practices.

There is an interesting methodological approach presented in the article "Inventory management and logistics optimization: a data mining practical approach" (2020) [44]. This study is a practical approach to optimizing inventory management and logistics using data mining techniques. The work is based on the analysis of data from a company from the food industry sector.

The author proposes a method for classifying inventories using qualitative and quantitative variables, such as the frequency of sampling, the rate of consumption, and the qualitative characteristics associated with their processing in the warehouse. The model also integrates material classification with facility layout techniques to support decision-making on inventory management and storage operations. The paper uses a method based on the Partitioning Around Medoids (PAM) algorithm, which involves the innovative application of a strategy to determine the optimal sampling point based on the classification of clusters, taking into account the qualitative and quantitative factors that are of the greatest interest or priority for inventory management in the company.

An overview of existing methods and practices is shown in the article "Performance measurement on inventory management and logistics through various forecasting techniques" (2021) [87]. This study is an overview of the various forecasting methods used to measure performance in inventory management and logistics.

The chapter "Inventory Management" in the book "Data Analytics", published in 2019 [45] on inventory management in the context of data analysis. The author of the chapter, Elise Hallstrom, is a recognized expert in data analysis and inventory management. In this chapter, she takes an in-depth look at the importance of inventory management in modern business and the role of data analytics in this process.

The chapter begins with an overview of the basic concepts of inventory management, including its goals, functions, and key metrics. Hallstrom then goes on to discuss the role of data analytics in inventory management, highlighting how modern technologies and data analytics techniques can help companies optimize their inventory and improve supply chain efficiency. The chapter also discusses various data analysis techniques and tools that can be used for inventory management, including statistical analysis, machine learning, and artificial intelligence. Hallstrom

provides a detailed overview of these methods, explores their advantages and disadvantages, and offers recommendations for their effective application.

The chapter concludes, Hallstrom discusses the future of inventory management in the age of big data and artificial intelligence, emphasizing the importance of continuous learning and adapting to rapidly changing technology trends to ensure effective inventory management.

The second group of scientific literature studied is devoted to the topics of inventory management in various areas and business sectors. In the article «Demand Forecasting Application with Regression and IoT Based Inventory Management System» (2022) [57The authors study the problem of IoT-based inventory management in semiconductor manufacturing, including the use of regression analysis and other statistical methods.

A similar study is presented by the paper "IoT in Inventory Management" [107] presented at the International Conference on Sciences and Applications in Decision Making (DASA) in 2022. In it, the authors explore the application of the Internet of Things (IoT) in inventory management in the retail sector. The authors analyze the current situation, the challenges of implementing IoT in inventory management, and the future prospects of IoT in this area, analyzing various technologies that are currently in use, such as RFID and IIOT, to optimize inventory.

A similar study, but adapted for small and medium-sized enterprises (SMEs), is presented in "Impact of inventory management practices on the operational performances of SMEs: review and future research directions" (2024) [92]. Its authors analyze the different approaches to inventory management used by SMEs and evaluate their effectiveness in terms of operational performance.

A significant contribution to the field of inventory management in the context of small businesses is "Performance implications of technological uncertainty, age, and size for small businesses" (2021) [36]. In it, researchers focus on the impact of technological uncertainty, age, and size on the productivity of small businesses. The authors analyze how these factors affect the ability of small businesses to effectively manage their inventory, consider the different scenarios and conditions in which these factors can have the greatest impact, and propose strategies for managing them.

The authors of the article «Inventory Management System for Mobile Showroom» [8] are researching an inventory management system for a mobile showroom. The paper discusses how an inventory management system can help control manual work in the showroom, maintain their performance, recordings, and ensure the security of data storage.

Article «Applications of Inventory Management In Construction Industry» (2018) [82] analyses the application of inventory management in the construction industry, in which the authors analyze the effectiveness of known approaches and methods for the construction industry,

and explore how they can be optimized to improve operational efficiency and productivity in the construction industry. The authors emphasize that in order to succeed in this area, it is necessary to constantly update and adapt these approaches in accordance with changing conditions and market requirements.

In the article «Decision analysis of warehouse productivity performance indicators to enhance logistics operational efficiency» (2023) [1] The authors analyze solutions related to warehouse performance in order to improve the efficiency of logistics operations. They research various performance metrics that can be used to evaluate and improve warehouse performance.

The third group of research we studied is related to supply chain inventory management (SCM). Judging by the number of scientific articles, this topic attracts the attention of researchers the most.

«Analysis of decision making and information sharing strategies in a two-echelon supply chain» (2021) [67] focuses on the analysis of decision-making strategies and information exchange in a two-tier supply chain. The authors analyze how different information sharing strategies can affect supply chain performance. They discuss what types of information can be most useful for sharing, and what technologies can be used to facilitate that sharing. The paper also provides examples of successful application of these strategies in real supply chains.

The authors of «An IM for global supply chain through reworking of defective items having positive inventory level under multi-trade-credit-period» (2022) [4] explore inventory management issues in the context of the global supply chain. They consider the specific situation where there are defective goods that can be recycled, while inventory levels remain positive, and a system of multiple credit periods is used.

In the article «Multi-objective solid transportation-location problem with variable carbon emission in IM: a hybrid approach» (2023) [35] The authors focus on solving the complex challenge of transporting and placing goods in a variable carbon footprint within a stockpile management system.

Thus, in the course of studying the literature, we have discovered a huge difference in the understanding of the term "inventory management" in Russian and foreign science and practice.

Summarizing the above, it should be noted that the considered models of inventory management are only an approximate description of the logistics processes observed in reality. In each of the models, restrictions are introduced on the real characteristics of logistics processes and several assumptions are made when forming calculation formulas. This situation is typical not only for inventory management models, but also for most other econ-mathematical models used to obtain optimal solutions to practical problems.

The more complex the problem under study, the more difficult it is to construct an adequate mathematical model for it, and the more assumptions must be made to carry out an analytical or numerical calculation. However, this does not mean that the above inventory management models should not be used to optimize the procurement and storage of tangible products. The values obtained in the calculations of these models, which are optimal under several constraints, should be used as a kind of "starting point", a scientifically grounded assessment of the final solution.

The final decision on inventory and procurement management should be made based on practical experience and the use of the results of the calculation of economic and mathematical models.

In Russia, inventory management is studied within the framework of the following scientific disciplines:

– Logistics – the discipline covers all aspects of supply chain management, including inventory management;

– Operations Management – Studies various aspects of operations management, including inventory management;

– Applied Informatics – studies the use of information technology to manage logistics operations, including inventory management;

– Economic Statistics – Studies the ways in which data is collected, analyzed, and interpreted that can be used to manage inventory4.

– Economic and Mathematical Methods and Models – studies the use of mathematical models and methods to solve logistical problems, including inventory management;

– Fundamentals of Supply Chain Management – studies inventory management in supply chains, among other things.

In foreign studies, inventory management is most often studied in one of two areas – supply chain management (SCM) or economics. At the same time, as in Russia, in Western practice, it is customary to separate production stocks and stocks of goods (Retail & Wholesale, or R&W).

In the course of the analysis of literary sources, it has been established that in science and practice there are several methods of supplying an enterprise with reserves, each of which is focused on the specific needs of the enterprise. Among them:

1. The Kanban method, developed in Japan, is designed to manage supply in a flow production environment. This method takes into account the need and allows you to minimize excess inventory.

2. The Material Requirements Planning (MRP) system covers planning at three levels. At the first level, program planning is carried out, then material distribution and procurement management. Actual deviations from the plan are transmitted through feedback to the planning

level, creating a closed system, which contributes to more accurate and flexible management of inventory and production processes.

3. The "Just In Time" (JIT) method aims to drastically reduce accumulated inventory through frequent and fractional deliveries. This can significantly reduce storage costs and minimize the risk of obsolescence of materials.

4. The request system involves the creation of standard contracts with suppliers for a long period. Data on actual demand are requested on the basis of a step-by-step clarification, which ensures flexibility and timeliness of deliveries in accordance with current production needs.

5. The method of forecast indicators is based on the formation of demand for large batches of purchases at a certain level, with the subsequent bringing of a specific volume of supplies in line with real demand. This allows you to optimize procurement activities and reduce the costs associated with storing excess stocks.

6. The electronic-informational method of communication between the customer and the supplier is based on the transmission of the necessary data through digital channels. Requests are received in the form of orders, and delivery and transportation data are updated in the mode of direct inter-computer communication. This method increases the speed and accuracy of order processing, improving the overall level of service and reducing operating costs.

These techniques, each with their own unique advantages, allow businesses to manage inventory efficiently, minimizing costs and maximizing meeting production needs.

The inventory management process includes several stages:

- determination of the volume of stock requirements;
- determination of the composition of costs associated with the creation and maintenance of inventories;
- calculation of the optimal size of the order to replenish the stock;
- coordination of the terms of replenishment of the stock;
- design of an inventory management algorithm.

Inventory management is carried out within the framework of the appropriate system.

An inventory management system is a set of methods, processes, and tools used to plan, control, and optimize an enterprise's inventory [40]. The main goal of such a system is to maintain an optimal level of inventory, which allows you to meet the needs of production and sales at minimal costs.

The main components of an inventory management system are:

- inventory planning;
- inventory control;
- inventory optimization

- supply management;
- information systems [42, p.183]..

At present, there are many inventory management systems, the most often mentioned in scientific sources are:

1. Fixed order size inventory management system. In this system, replenishment orders are made every time the inventory level drops to a certain minimum level. The size of the order remains constant.

2. Inventory management system with a fixed time interval between orders. Orders are placed at fixed intervals, regardless of the current inventory level. The number of items ordered may vary depending on needs.

3. Inventory management system with replenishment of stock to a constant level. Stocks are replenished to a predetermined level every time they drop to a certain point. This allows you to maintain a constant level of inventory.

4. Inventory management system "Minimum - maximum". Stocks are replenished to the maximum level when their quantity reaches the minimum allowable level. This system helps to avoid both excess inventory and shortages.

5. The "two baskets" system. Two storage baskets are used. When the first cart is emptied, a refill order is placed and usage continues from the second cart. This method is easy to implement and manage.

6. ABC method. Inventories are classified into three categories (A, B, C) according to their importance and value. Category A includes the most valuable products with a low order frequency, B – intermediate products, C – the least valuable products with a high order frequency. Inventory management is carried out considering this classification.

7. Method XYZ. Inventories are classified according to the degree of predictability of their use. Category X includes goods with predictable and stable demand, Y – with moderate predictability, Z – with irregular and difficult to predict demand. Inventory management depends on the predictability of consumption.

These systems present different approaches to inventory management that can be adapted depending on the specifics of the business and its needs.

2.2 Analysis of international practices in the field of inventory management

Inventories as an economic category are an integral element of the sphere of production and circulation of products. Inventories They are a set of objects of labour that are used in the

production process (e.g., stocks of raw materials and materials) or a set of values that result from the production process or commercial activity (e.g., finished goods or inventories) [52].

For organizations operating in the field of trade, inventory management is especially important, since such inventories are always an integral element of working capital, which means that the speed of their turnover has a direct impact on the turnover of the entire set of funds of the organization [79].

At the level of commercial organizations, inventories are the element that requires large capital investments, in this regard, inventories are one of the key factors that determine the direction of the organization's financial policy and affect the entire logistics system as a whole. However, many Russian companies do not pay enough attention to this element, often underestimating their need for inventory. Because of this, organizations tend to be faced with the need to invest even more in inventory management than previously anticipated.

Indeed, a situation in which the production process is forced to suspend due to the lack of any material in the warehouse is extremely unpleasant and is considered completely unacceptable in most enterprises. At the same time, the situation becomes even more complicated when the inventory nomenclature contains hundreds, thousands of items of material resources used in the production process, each of which must be available and available at any given time. This necessitates the effective and rational management of inventories.

On the other hand, no enterprise can afford to create excess inventory, when individual material resources lie in the warehouse for so long that they become unusable over time and must be disposed of.

In the context of international practices, many companies are moving towards more flexible and adaptive inventory management models. One such approach is the concept of Just-In-Time (JIT), which involves minimizing inventory through precise planning and coordination of deliveries. This approach allows you to reduce storage costs and reduce the risks associated with the obsolescence of goods.

It is also worth noting the approach based on the use of artificial intelligence and machine learning to predict demand and optimize inventory levels. This approach allows you to take into account a large number of factors and adapt to changing market conditions.

In addition to the above-mentioned approaches, there are other concepts of inventory management that can be applied in different contexts. For example, the concepts of maximizing, optimizing, and minimizing inventory. These approaches can be adapted depending on the specifics of the business and market requirements.

Effective inventory management is critical for retailers and wholesalers. For example, Target stockpiled inventory after the start of the COVID-19 pandemic to respond to a surge in

demand. However, in the second quarter of 2022, Target offered consumers deep discounts and canceled orders from suppliers to quickly reduce excess inventory, resulting in low margins and bottom line [71].

Similarly, wholesaler Adidas started ordering more inventory earlier than usual in response to supply chain issues related to COVID-19, but found itself with excess inventory by the second half of 2022 [86]. In addition, Adidas' inventory problems were exacerbated by the end of its partnership with the celebrity brand, which led to the accumulation of outdated inventory associated with it. Such inventory accumulations required Adidas to offer discounts on products and, as a result, affected margins [83].

International methods in the field of inventory management include various methodologies and approaches that are used to optimize inventory management processes:

– Just-In-Time (JIT) is an approach to inventory management that seeks to minimize inventory through accurate planning and coordination of deliveries.

– ABC analysis is a method of classifying reserves based on their significance. Typically, inventories are classified as A (most important), B (medium importance), or C (least important).

– EOQ (Economic Order Quantity) is a method for determining the optimal order quantity to minimize the total cost of storing and ordering inventory.

– Safety Stock is an approach that maintains a certain level of inventory to ensure continuity of operations in the event of unforeseen fluctuations in demand or supply delays.

Rational inventory management enables an organization to ensure predictability and continuity of the production process and commercial activities, while spending minimal money on inventory maintenance.

Inventory management always involves their optimization of their actual value, i.e. the purchase of the necessary material resources in such a nomenclature and in such volumes that best correspond to the nature of the main activity [44].

The concept of inventories is considered one of the key in logistics in general. Raw materials extracted from nature, before appearing in the form of a finished product in front of the end consumer, undergo transformation, transformation, movement, combine with various other materials, and undergo various technological processes. Moving along the material-conductive chain, material resources (which are further transformed into semi-finished and finished products) are subject to periodic delays, from time to time waiting for their turn at one or another technological or production stage.

The concept of stock is inextricably linked to the sphere of material production, since the material flow, as it moves from the original source of raw materials to the final user, can accumulate in the form of a stock at some stage. Inventory management is characterized by a high

degree of individuality, and can have its own specifics at any stage of the supply chain at any stage of the production process [82].

If we imagine that the entire logistics chain, which ensures the transformation of raw materials into finished products and the movement of these raw materials through the stages of the production process, worked as a single well-coordinated mechanical conveyor, then the waiting time for raw materials in any part of such a system would be practically non-existent, and the need for any inventory would be reduced to zero.

However, in reality, such logistics systems do not exist. Waits and delays occur for a variety of reasons, they are integral elements of modern product movement. Therefore, organizations seek to create stockpiles in order to be able to use them in their core business for the foreseeable future.

Stockpiling in a way that is acceptable to a particular enterprise is always associated with costs to some extent. The costs that accompany the process of creating and storing inventory can include, for example:

- partial diversion of temporarily free cash into reserves (i.e., intentional and purposeful reduction of the liquidity of assets for the sake of making a profit in the future);
- financing the maintenance of warehouses;
- financing the costs of maintaining the infrastructure and related manpower to move inventory from the storage area to the production area;
- wages to personnel engaged in warehouse and procurement logistics;
- costs associated with the ever-present risk of deterioration, theft, and other ways of loss of inventories (e.g., within the limits of natural loss).

This is not an exhaustive list of costs. Depending on the type of reserves, the requirements for their storage, and their useful life, the amount of costs for the creation and maintenance of inventories may vary.

Thus, the availability and management of inventory always involves various additional costs. At the same time, the lack of inventory also forces the organization to incur some expenses, these costs are usually expressed in the form of various losses [104]. Such losses may include, for example, the following:

– losses from interruptions are not easy in the production process;

– losses due to the lack of a specific item in the warehouse at the right time;

– losses from the purchase of small quantities of inventory at inflated prices and other similar losses associated with deficiencies in the organization of procurement logistics and marketing.

From the above, it follows that stocks of material resources in a commercial organization require a careful and balanced approach in the process of their management. Each type of stock

has its own specific properties that determine the conditions for their formation and management methods.

In the process of transforming initial inventories into a finished product that is entirely intended for use by the end user, two main categories of inventories are usually formed: production and commodity. Within each of these categories, it is also possible to divide stocks into the following types: current, insurance and seasonal. A more detailed classification of inventories is presented in table 11.

Table 11 – Inventory Classification

Characteristics of Inventory Classification	Types of Inventories
Material Inventory Groups	• raw materials; • basic Materials • auxiliary materials; • semis; • components; • spare parts; • fuel and energy carriers; • tools and inventory; • production and consumption waste; • consumer goods (food and non-food products)
Location	• total; • manufacturing enterprises; • wholesale and trade enterprises; • retailers; • on the road
Nature of immobilization Resources in Inventories	• mobile; • inert
Attitude to logistics processes	• warehouse; • transport (in transit and transit)
The position of inventories in production and commercial Activities	• production; • work-in-progress; • commodity
Functional purpose	• current; • preparatory; • insurance; • seasonal; • illiquid assets; • state reserve
Units	• in physical units; • in units of value; • in days of security
Value of reserves in relation to the norm	• within normal limits; • excess (abnormal)

Note: Compiled by the author.

As Table 11 shows, there are at least eight different criteria for classifying inventories according to various attributes, such as groups, location, logistics, the role of inventories in the organization's operations, functional purpose, and other relevant criteria.

Illiquid inventories are a big problem for any business. This includes any long-term unused inventory. Usually, the company can neither sell them at an acceptable price nor use them in its activities for various reasons.

Thus, even though the maintenance of inventories is often associated with certain costs, inventories are an integral attribute of any production or commercial activity. This is because a lack of inventory can have a negative impact on production and financial results.

An increasing number of foreign companies are introducing artificial intelligence, IoT, big data and other innovative technologies into the inventory management system.

One of the largest retail giants in the world, Walmart, is actively applying artificial intelligence and IoT technologies to optimize its inventory management system, using data analytics and machine learning algorithms, Walmart predicts demand for goods, optimizes inventory in warehouses, and automates ordering processes.

Companies such as Amazon and Alibaba Group are global leaders in e-commerce and inventory management. They have developed and implement their own innovative inventory management systems that allow them to efficiently manage huge volumes of goods and ensure fast delivery of orders.

Amazon, for example, is known for its advanced inventory management system called Amazon Fulfillment. This system includes intelligent inventory planning and management, automated picking of goods from stock, optimized logistics and fast delivery. Amazon actively uses machine learning technologies and algorithms to predict demand, optimize inventory, and manage the order process. In addition, Amazon is implementing innovative solutions such as robotic warehouses and automatic sorting systems to improve the efficiency of its inventory management system.

Alibaba Group has also developed its own advanced inventory management system, which includes an integrated platform for order, logistics, and warehousing management. It provides sellers with the ability to manage their inventory efficiently, ship goods quickly, and ensure fast delivery rates for their customers. Alibaba Group is actively developing technologies and algorithms to optimize inventory management, including demand forecasting systems and warehouse automation.

Chinese internet giant JD.com. like its main competitor Alibaba Group, it is actively implementing artificial intelligence and IoT, using drones and self-driving cars to deliver goods, as well as machine learning algorithms to optimize inventory in warehouses and forecast demand.

The Chinese retail market (including online retail) is the largest market in the world in terms of volume and turnover due to its population.

JD.com and Alibaba Group work in the field of e-commerce, but their business models are not similar. Alibaba is primarily a platform where third-party sellers offer their products, and the company receives a fee for this, without dealing with packaging, logistics, etc JD.com. The company sells the products themselves, including processing, transportation, packaging, etc. JD also offers a platform for third-party sellers, but this is not its main business, which is different from Alibaba.

Both JD.com and Alibaba Group use advanced technologies and innovative approaches to inventory management, which makes their systems similar in some aspects to the system we propose in Chapter 3. Both companies are actively implementing machine learning, data analytics, and process automation technologies to ensure efficient inventory management and order delivery.

Global fashion brand Zara is using IoT in its stores and supply chain to track inventory and manage inventory. Each garment has an RFID tag that allows Zara to know exactly what items are in stores and quickly update inventory.

Procter & Gamble is applying artificial intelligence and IoT to its inventory management system to optimize manufacturing processes and the supply chain. They use IoT sensors on production equipment to monitor efficiency and prevent downtime, as well as data analytics to improve inventory planning.

Historically, complexity and redundancy have often led to complex control systems that require significant time and cost to implement and maintain. However, with the advancement of technology, the pursuit of simplification and efficiency is becoming more important. Today, companies are increasingly looking for innovative solutions that not only ensure optimal inventory management, but are also easy to use and implement.

Simplicity and efficiency are becoming key criteria for success in inventory management. Technology solutions that offer visibility, automation, and process optimization without undue complexity are increasingly being used in business. This allows companies to significantly improve their competitiveness, reduce costs and increase the efficiency of their activities.

In our opinion, in the race of innovative technologies used in inventory management systems, the approach that provides the simplest and most effective solution will win. In the future, this solution will become the industry standard for decades to come and set the trend for the entire industry. It will inspire other companies and set new trends, changing the paradigms of inventory management and bringing new opportunities for more successful business.

2.3 Assessment of the possibility of introducing an alternative inventory management method

This study is aimed at developing and implementing a method aimed at improving the efficiency of inventory management in trade enterprises, which is especially important in a dynamically changing market environment.

Let's consider what the essence of the proposed method is. The theory of queuing, which is a branch of applied mathematics, is devoted to the creation of mathematical models that link the conditions for the functioning of queuing systems with their efficiency indicators. Initially, this theory was used to optimize telephone networks, where its methods made it possible to assess the efficiency of customer service depending on the number of communication channels. At present, mathematical models of the queuing theory are widely used in various fields, including the organization of trade processes, the management of the machine fleet of enterprises and the calculation of airport capacity.

The flow of events in queuing theory is defined as a sequence of random events that occur at irregular points in time. Any queuing system includes the following basic elements: inbound requirements flow, service channels, requirements queue and outbound requirements flow.

Based on the principles of queuing theory, inventory management involves the analysis and modeling of these key elements to optimize processes in retail enterprises. The incoming flow of requirements can be interpreted as replenishment needs, service channels as the company's ability to meet these needs, and the demand queue as the accumulation of replenishment requests requests, which contributes to maintaining the required level of inventories (Figure 2) [18].

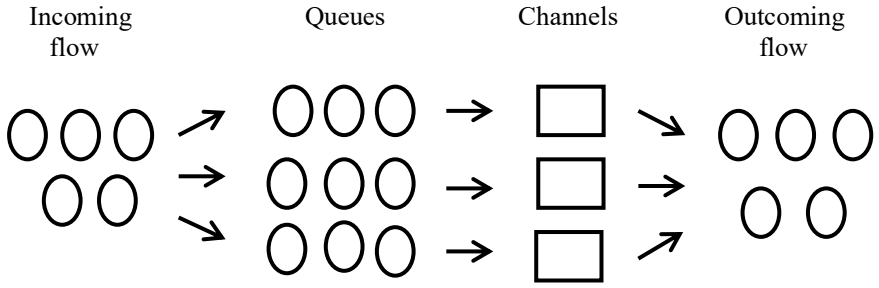

Figure 1 – Structure of the queuing system

If such requests are received at regular intervals, then the flow is called regular. However, regular flows are rare; In economic practice, irregular and random flows are more common. This is what makes an inventory management system complex and unpredictable.

A requirement or requisition is each individual request to perform a specific job or satisfy a specific need. Service is understood as the process of satisfying these needs

Service is understood as the satisfaction of needs. In our case, maintenance (i.e., fulfillment of the requirement) is the release of the right product, in the right quantity and at the right time from the inventory management system.

Service channels are technical devices or personnel that perform the corresponding functions. In our case, a service channel is a specific commodity item in the inventory management system. Each channel can serve only one requirement at a time. When all channels are busy with maintenance, the new requests entering the system become queued.

A queue is a collection or aggregation of requirements that are waiting to be serviced.

The main parameters of the incoming flow of requests include the flow intensity λ - the average number of requests received by the queuing system per unit of time:

$$\lambda = {}^{1}/_{\tau}$$

where τ is the average value of the interval between two adjacent orders.

The main parameter of the service flow is the intensity (or "speed") of the service flow μ - the average number of requests that can be served per unit of time.

$$\mu = {}^{1}/_{\bar{t}_{serv}}$$

where $\bar{t}_{serv}$ is the average service time of one request. The μ parameter is called the queuing system throughput.

The value $\rho = {}^{\lambda}/_{\mu}$ is called the intensity of the load of the service channel (this is also called the "load factor" of the queuing system). It represents the average number of requests received during the average service time of one request.

The processes that occur in the queuing system depend on the characteristics of the demand flows. The main properties of demand flows include stationarity, absence of consequence, and ordinariness.

A stationary flow is a random flow of requirements in which the probability of the occurrence of k requirements in any time interval of duration τ depends only on the values of k and τ and does not depend on the starting point of this interval. For a stationary flow, the intensity of the flux λ remains unchanged in time.

A random flow of requirements has the property of no aftereffect if the probability of k requirements appearing within a period of time (T, T+τ) does not depend on how many requests entered the system before the moment T.

The flow of requirements is considered ordinary if the probability of two or more requirements appearing in a short period of time Δt is negligible compared to the probability of appearing one request. The ordinariness of the flow of requirements means the practical impossibility of the appearance of two or more requirements at the same time.

If we denote the probability of more than one request appearing in a period of time Δt through $P_{>1}(\Delta t)$, then the condition of ordinariness means $\lim_{\Delta t \to 0} P_{>1}(\Delta t) = 0$. Hence $P_{>1}(\Delta t)=\alpha(\Delta t)$, where α(Δt) – infinitely small quantity at $\Delta t \to 0$.

The simplest flow is the flow of requirements, which has the properties of stationarity, non-consequence, and ordinariness. The mathematical description of the effect of such a flow on systems turns out to be the simplest.

Let λ be the average number of requests that are received by the queuing system per unit of time. of time. Then the probability of the occurrence of k orders of the simplest flow in time t is determined by Poisson's formula:

$$P_k(t) = \frac{(\lambda t)^k e^{-\lambda t}}{k!}$$

This formula reflects all the properties of the simplest flow. In this regard, the simplest flow is called Poisson flow. Let's determine the probability of non-occurrence of requirements $P_0(t)$ in an infinitely small time period Δt. According to Poisson's formula $P_0(t) =(\lambda\Delta t)^0 e^{-\lambda\Delta t}/0! = e^{-\lambda\Delta t}$. By virtue of the ordinariness of the simplest flow $P_0(t) + P_1(t) = 1$. Hence the probability of the appearance of one demand $P_1(\Delta t)$ of the simplest flow for a time period Δt is calculated by the formula $P_1(\Delta t) = 1 - e^{-\lambda\Delta t}$.

Thus, it can be argued that the parameters of the queuing system can be used in the design of an alternative system for inventory managment.

2.4 Formulation of objective requirements for the inventory management system

A necessary condition for predictable and stable operation of a commercial organization is its full provision with material resources. It is important for professionals to understand the principles and limitations of stockpiling. The efficiency of employees and the company's profit depend on it [114].

Speaking of material resources in relation to the sphere of material production (the essence of which is the transformation of these resources into a finished product), the concept of "need" for resources is used.

The need for material resources is understood as "the amount of material resources required by a certain date for a specified period to ensure the fulfillment of a given production program or existing orders."

As a rule, the need for material resources is determined on the basis of the nature, characteristics and needs of the production program. The main task of effective inventory

management is to determine how much inventory should be in the warehouse at a given time. Being able to model the amount of consumption of available stocks for arbitrary periods in the future, we can talk about forecasting stocks and modeling the movement of stock balances in the warehouse by days [33].

The goal of inventory planning is to predict changes in inventory balances from the beginning to the end of the period and understand how much inventory will be stored in the warehouse each day, what the consumption will be, and whether there will be enough inventory to cover that expense.

Inventory acquisition can be carried out by different methods depending on the type of material resources [45]. The main methods of acquiring them are:

– wholesale purchases (a large batch is purchased at one time);

– regular purchases of materials (the essence is that the buyer orders the required amount of materials in advance, which are delivered to him in small batches over a certain period, this makes sense when the buyer knows exactly how much stock is spent in the future);

– daily (or other periodic) purchases of material resources. This is a very common scheme, most often it is used to purchase inexpensive materials in large volumes;

– obtaining stocks of material resources as needed, based on existing contractual obligations for their supply;

– one-off purchases. This is usually the most expensive way to replenish material resources, and is only used when no other replenishment methods can be used.

In order to manage inventories competently, it is necessary to take into account the risks of losses - overpayments, underdeliveries, shortages, abnormal demand. Classical demand forecasting models do not take into account their probability.

The delivery and storage of material stocks require financial expenditures necessary to ensure a sufficient level of production rhythm. The formation of an excess volume of inventories is considered unacceptable, usually as a result of errors in the planning of their purchase, usually this scenario is tried to be avoided. Excess stocks are the main reason for the formation of illiquid stocks and, accordingly, an increase in the cost of warehouse operations associated with their storage. The opposite situation is also undesirable, when the available stocks are insufficient for current operations, which is fraught with a shortage of inventory, a temporary cessation of production and a decrease in profits.

There are three main categories of order models:

- a model with constant control;
- model with a fixed order point;
- a model with a fixed order quantity.

The order model with constant control is the simplest in the organizational sense, it consists in the fact that the responsible employees of the organization determine every day whether to place an order or not. The undeniable advantages of this model are that the organization always knows exactly how much stock is left, how long it will last, and what the rate of consumption of existing stocks is. In addition, even very small orders can be made with this model, and at any interval, as material resources are used up in the production process. Such a model is widespread, for example, in the order-based mode of production, where production volumes can vary widely in different periods of time.

The fixed order point model consists in the organization of a minimum critical point for each type of inventory, below which the inventory quantity must not fall. That is, when the stock approaches this point, it must be replenished immediately. The situation described above is a classic example of a fixed-schedule ordering model.

The fixed order quantity model is based on the fact that for each type of inventory, a certain maximum allowable volume is determined, which the volume of inventory should not exceed, and the organization periodically makes purchases in a certain fixed volume, taking into account the rate of consumption, so as not to exceed this value. In the event that the stock level runs out earlier than planned, the organization makes an “out of order” order.

Order lead times are essential in all inventory management models. In reality, it is almost impossible to have a situation where so little time passes from the moment the order is made to the moment material resources arrive at the warehouse that it can be neglected. Most often, the execution of an order takes some time, often quite long (up to several days or several weeks), this is due to the specifics of procurement logistics, the specifics of order processing by the supplier, the features of delivery options, loading and unloading operations and other logistics operations through which material resources pass before being placed in the warehouse and ready to participate in the production process.

Most often, in practice, they encounter deterministic or probabilistic lead times [67].

In the theory of procurement logistics, there are several different types of supply systems – decentralized, linear, layered, or mixed [42].

A decentralized supply chain involves multiple deliveries from multiple suppliers, with each supplier controlling its own delivery channel. This scheme is used in the vast majority of small enterprises.

The linear supply system provides for the delivery of material resources from all suppliers to a single distribution center, which subsequently supplies the enterprise centrally.

A layered supply chain is very similar to a linear supply chain, but it differs in that a company has several distribution centers (for example, one main and several regional distribution centers).

These options are not necessarily separate supply chains, but in practice they are often combined.

Thus, it can be concluded that meeting the needs of the enterprise in material stocks requires a systematic organization, separate management and control. Thus, all these circumstances also support the need for systematic inventory planning.

As it was shown above, systematic planning of material inventories requires certain organizational efforts, managerial influences, and control from an economic entity. The nature of this activity is based on how efficiently the supply of material stocks to the enterprise is organized at a given time.

Summarizing the above, the following conclusions can be drawn.

The need for effective inventory management to ensure stable operations and increase the profitability of an organization is important for logistics and supply chain professionals. To develop an alternative inventory management system in TH Megapolis LLC, it is necessary to determine objective requirements based on the principles and limitations of inventory formation.

For competent inventory management, you need to consider the risks of loss, such as delays, lack of goods and abnormal demand, as well as the financial costs associated with shipping and storing inventory.

One of the key requirements for an inventory management system is to avoid the formation of excess inventory, which can lead to an increase in the cost of storing them, as well as insufficient inventory, which can lead to a temporary shutdown of production and a decrease in profits.

The main issue in inventory management is to ensure the optimal level of inventory so that there are always only as many goods in the warehouse as are necessary for the current activities of the company.

One way to ensure optimal inventory levels is to use order management models that determine exactly which material resources to order, when, and where to order them. It is necessary to consider the different ways of forecasting demand and establish effective order management strategies.

The formulation of objective requirements for the inventory management system is an important step in the design of an alternative system for TH Megapolis LLC. Taking into account risks, preventing over- and under-inventory, and determining the optimal inventory level will help ensure the stability and efficiency of a company's business.

In addition to analyzing experience and current inventory management methods, we will also turn to foreign experience to develop an alternative system. The experience of major global companies such as Amazon and Alibaba Group provides a valuable knowledge base and best practices in inventory management.

Particular attention will be paid to the use of innovative technologies, algorithms and automation systems that allow you to effectively manage large volumes of inventory and ensure fast delivery of orders.

This approach will allow you to adapt the best inventory management practices from the experience of world industry leaders to the needs and features of the business of the company in question - optimization of order management processes, the use of innovative demand forecasting strategies, the use of modern warehouse accounting and control systems, and other innovative inventory management methods developed by large global companies.

CHAPTER 3 IMPROVEMENT OF THE INVENTORY MANAGEMENT SYSTEM AT TH MEGAPOLIS LLC

3.1 Development of an alternative method for inventory management

Modern trading enterprises, including TH Megapolis LLC, face numerous challenges related to effective inventory management. Increased competition, changes in consumer preferences and increased trading volumes require the use of advanced techniques and tools to optimize inventory. This paper proposes an alternative method of inventory management based on the queuing theory, which will improve the processes of planning and distribution of goods.

The logic of the proposed method is as follows.

Queuing theory, which has its roots in Poisson's computational mathematics, is a mathematical approach to the analysis and optimization of systems where requests (requirements) are served. The application of this theory to inventory management allows you to consider each item as a separate service channel, which greatly simplifies and structures the management process. Thus, we have an inventory management system that works as a queuing system (QMS) and very, very many service channels, which involves the management of "Big Data".

Within the framework of the proposed method, the inventory management system is considered as serving the main activity of the company, including wholesale and retail trade. At the same time, each stock item becomes a service channel through which requests for goods pass. When the warehouse receives a request for a certain product in a given quantity and time, the system checks the availability of this product. If the goods are in stock, they are immediately sent to the customer or moved to the sales area. In a situation where the goods are not available, the system goes into standby mode, turning into a queuing system.

Earlier, we identified the shortcomings of the existing inventory management system in TH Megapolis LLC. Let's consider how exactly the alternative inventory management method based on the queuing theory proposed by us helps to eliminate these shortcomings.

Disadvantage 1. Limited forecasting methods. An existing inventory management system can estimate demand based on historical data, but it doesn't always take into account seasonal fluctuations, marketing promotions, and other factors that can affect demand.

The proposed inventory management method, based on the queuing theory, helps to correct the first drawback associated with limited forecasting methods by introducing more complex and flexible data analysis models.

Firstly, the queuing system allows you to take into account seasonal fluctuations in demand and marketing promotions through the analysis of the flow of requests and their distribution over time. Unlike a traditional system that uses historical data to forecast demand, a queuing system uses current data and models based on probabilistic characteristics to provide more accurate forecasting.

Secondly, the queuing system introduces more control parameters than Wilson's formula, namely: ticket flow, probability of failure, probability of service, number of busy channels, number of busy channels, service time, waiting time in queue, idle time, throughput, service efficiency, service level, probability of blocking, probability of overflow, average number of requests in the system, etc. adapt to changes in demand. For example, when there is a sharp increase in demand for a certain product, the system can allocate additional service channels (shelves) for this product, which allows you to avoid shortages.

Thirdly, the use of "big data" analysis methods within the queuing system makes it possible to take into account many factors affecting demand that could not be taken into account in the traditional system. This includes marketing promotions, seasonal changes, the impact of external events, and other determinants of demand. In this way, forecasting becomes more accurate and flexible.

In addition, constant monitoring and updating of data in real time allow the system to quickly respond to changes in the market situation. Instead of the static approach that Wilson's formula uses, a queuing system provides continuous updates and automatic adjustments to inventory management parameters.

As a result, the proposed inventory management method allows you to significantly improve the accuracy of demand forecasting and, accordingly, optimize inventory levels, which contributes to improving the efficiency of the commercial activities of TH Megapolis LLC and meeting the needs of customers.

Disadvantage 2. Lack of dynamic optimization. The existing inventory management system does not take into account changes in demand and supply in real time. It calculates orders based on static data, which can lead to incorrect decisions in dynamic changes.

There is every reason to believe that the proposed inventory management method, based on the queuing theory, can effectively eliminate the second drawback, the lack of dynamic optimization, through the introduction of adaptive mechanisms and continuous monitoring of the state of inventories.

First of all, the queuing method allows for automatic adjustment of inventory levels in real time. Unlike static systems, queuing is a dynamic system that uses algorithms that continuously

update inventory and demand data, instantly adapting control parameters in response to changes. This ensures timely replenishment of inventory and prevents both excess inventory and shortages.

In addition, the proposed method implements more complex optimization models that take into account multiple influencing factors, such as changes in supply, variations in demand, as well as external economic conditions. This allows the system to not only respond to current changes, but also to predict possible future fluctuations, improving the accuracy and efficiency of inventory management.

Also an important aspect is the integration of the system with external data sources, such as information from suppliers, data on market trends and weather conditions. This integration allows the system to more accurately predict and adapt to changes, thereby providing more flexible and accurate inventory management.

As an additional option, the queuing method contributes to improving communication between different departments of the company. This is achieved through a centralized inventory management platform that provides up-to-date information to all stakeholders. Improved communication and access to up-to-date data allow for more effective coordination of inventory management activities, reducing the likelihood of errors and speeding up the decision-making process. This provides high flexibility and accuracy in inventory management, contributing to improving the efficiency and sustainability of the commercial activities of TH Megapolis LLC.

Disadvantage 3. Insufficient automation. The existing inventory management system requires manual intervention to generate orders, track deliveries, and update inventory levels.

In contrast, a queuing system can automatically generate orders, track deliveries, and update inventory levels based on current data, reducing the need for manual intervention and improving inventory management efficiency.

Automation of inventory management is achieved by integrating the system with modern information technologies such as the Internet of Things (IoT) and artificial intelligence (AI). IoT sensors installed in warehouses can monitor inventory levels, storage conditions, and the condition of goods in real time. This information is automatically transmitted to the control system, allowing it to react instantly to changes without the need for manual intervention.

Moreover, when controlling artificial intelligence, this system can become self-learning, and do not require the attention of operators at all. The use of machine learning algorithms and predictive analytics allows the system to independently analyze historical data and current trends for automatic order formation. Artificial intelligence is able to take into account many factors, such as seasonal fluctuations, promotions, and changes in demand, optimizing the replenishment process. This significantly reduces the need for manual work and minimizes the risk of errors.

A good addition can also be the introduction of automated warehouse management systems (WMS), such a measure ensures high accuracy and efficiency of warehouse operations. WMS systems automate the tasks of placing goods, picking orders, packing and shipping, which speeds up all processes and reduces the likelihood of human errors. As a result, the time spent processing orders and updating inventory levels is significantly reduced.

Automation also includes integration with supplier systems and logistics companies. This allows you to automatically exchange data on deliveries, track their status and adjust replenishment plans in a timely manner. This integration provides visibility and synchronization across the supply chain, improving manageability and reducing the risk of delays.

In addition, process automation allows for the implementation of real-time quality control systems. This means that defective or substandard items are identified immediately, and the system automatically takes action to replace or return them, minimizing the impact on overall inventory and customer service.

All this ensures more efficient, accurate and timely inventory management, which significantly increases the overall efficiency of the commercial activities of TH Megapolis LLC.

Disadvantage 4. The inventory management system does not take into account the variety of goods. The existing inventory management system does not always take into account this complexity and can only apply general approaches to inventory management, does not take into account the individual characteristics of goods. The fourth disadvantage associated with not taking into account the variety of goods can cause big trouble for the company at any time.

Nevertheless, even this problem can be solved in the queuing system, due to a differentiated approach to the management of various categories of goods.

The queuing system allows you to classify goods based on their characteristics and consumer demand, using cluster analysis methods. This allows you to create specialized (unique) service channels for different groups of goods, taking into account their unique features. For example, goods with high demand and a short shelf life can be managed by a separate channel, which ensures their timely replenishment and minimizes losses due to overdue periods.

The proposed approach includes the use of adaptive management strategies for each category of goods. Products can be grouped by parameters such as turnover rate, margin and seasonality. This allows you to apply different inventory management models for each group, optimizing inventory levels and replenishment strategies. For example, a "just-in-time" strategy can be used for items with a high turnover, minimizing inventory and reducing storage costs, while items with low turnover and high value can have a higher level of guaranteed inventory.

The information can be presented in the form of a table to summarize how each deficiency can be addressed using the proposed inventory management system (table 12).

Table 2 – Options for eliminating deficiencies

Disadvantage	Method of elimination using the proposed inventory management system
1. Limited forecasting methods	Taking into account seasonal fluctuations and marketing promotions when forecasting demand. The basis for a forecast based on big data.
2. Lack of dynamic optimization	Real-time, adaptive inventory management based on dynamic changes in demand and supply.
3. Lack of automation	Automate the processes of generating orders, tracking shipments, and updating inventory levels.
4. Inventory management system does not take into account the variety of goods	Classification of goods based on their characteristics and consumer demand. Apply specialized management strategies for different product categories.

This table concisely shows exactly how each of the four drawbacks can be addressed by the proposed inventory management system, ensuring better efficiency and adaptability of trading activities.

Here are a few examples.

There is a variety of products in TH Megapolis LLC, including both fast-moving products, such as high-grade wheat flour and white rice, and less popular ones, such as quinoa flour and organic rye grain. For the former, the queuing system can establish frequent small deliveries, given their high demand and short shelf life, which minimizes the risk of shortages and delays. At the same time, for products with a longer sales cycle, such as quinoa flour and organic rye grains, the system can provide for the optimization of storage locations and periodic replenishment based on forecasted demand.

During the holiday season, the demand for certain categories of goods, such as corn kernels for popcorn and selected oat grains, increases significantly. The queuing system allows you to separate these categories into separate channels, ensuring their priority replenishment and fast processing of orders. This helps to avoid situations where high-demand products are in short supply, while less popular products take up warehouse space. This is another undoubted advantage of the queuing system.

Thus, the proposed approach allows you to take into account the diversity of goods through the use of cluster analysis, adaptive management strategies and specialized service channels. This provides more accurate and efficient inventory management that corresponds to the specifics of each product category, which significantly improves the overall efficiency of the commercial activities of TH Megapolis LLC.

3.2 Recommendations for the implementation of an alternative inventory management method at TH Megapolis LLC

The main goal of queuing system is to provide a high level of request service with minimal costs for the creation and maintenance of these systems. The quality of the queuing system work means not only the organizational level of service, but also the load of service channels, the frequency of downtime and the number of unsatisfied requests.

The solution of these tasks includes the analysis of quantitative indicators of the functioning of the queuing system and their dependence on the parameters of the incoming flow, service flow and system structure. In addition, the economic efficiency of the queuing system is considered.

Effective management of the queuing system requires constant monitoring and analysis of all aspects of its work. Quality of service assessment and cost optimization should be the main priorities in the development of a queuing system management strategy. Quantitative methods, such as modeling and data analysis, play an important role in determining the optimal parameters of the system's functioning. A queuing system requires a constant flow of incoming requests. Without incoming requirements, the system will not exist. Only the quality of the service provided can ensure the long-term receipt of claims, because it is the quality, along with the cost, that determines the choice of consumers today.

In order to ensure high-quality processing of incoming requests, it is necessary to take into account the time the request is in the queue and the time it takes to process one request by the service channel. These two factors are the main indicators of the quality of service provision within the queuing system. When calculating these indicators, it is necessary to take into account the multi-channel nature of the system and the specifics of the time the request is in the system. The shorter the time the request is in the queue and the less time it takes to process the request of one client, the faster the process of accepting requests will be and the less time the consumer will need to meet their needs.

For a more in-depth analysis of the time spent on processing orders, it is necessary to use a variety of quality management tools. One such tool is the Fishbone Causal Diagram, which can identify key problems, including reduced maintenance time. The process of building this diagram identifies the causes that, if resolved, can help solve this problem.

Take, for example, the analysis of customer service time in a warehouse. Use a cause-and-effect diagram to identify factors that contribute to service delays and inefficiencies. These can range from technical problems, such as equipment malfunctions, to organizational aspects, such

as inefficient allocation of resources or insufficient staff skills. Such research will help identify key areas for improving the service process and increasing its efficiency. (Figure 3).

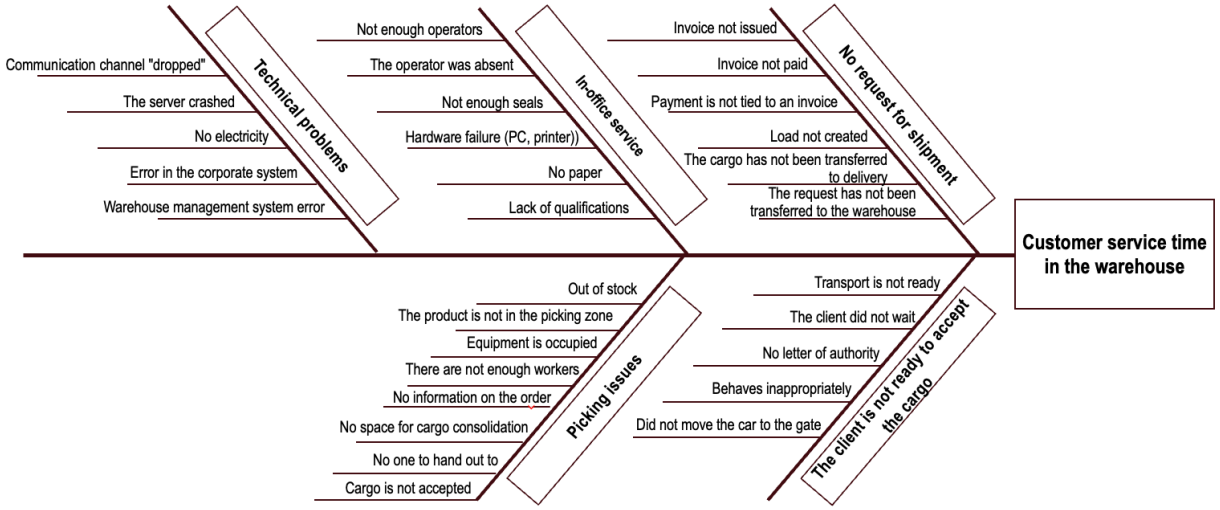

Figure 3 – Causal diagram of "customer service time in warehouse"

Highlighting the main causes of this problem:

- absence of a request for shipment;
- inadequate service in the warehouse office;
- technical problems;
- unpreparedness of the client to receive the cargo;
- problems caused by the selection of goods.

Thus, we can formulate recommendations for the implementation of an alternative inventory management method in TH Megapolis LLC.

1. Preliminary analysis and preparation

1.1 Assessment of the current system. Conduct a detailed analysis of the existing inventory management system, including the current processes of accounting, storage and distribution of goods. Identify key performance indicators and identify areas for improvement.

1.2 Education and training of personnel. Organize training for employees in the basics of queuing theory and new inventory management techniques, including the use of computational Poisson mathematics. Ensure that all levels of staff understand the principles of the new system.

2. Technical implementation

2.1 Software development. Create or adapt existing inventory management software capable of integrating the principles of queuing theory. The program should automatically process requests, track the availability of goods and manage queues.

2.2 Integration with current systems. Ensure the integration of new software with existing enterprise systems (ERP, CRM, etc.), which will improve coordination between different departments and increase the overall efficiency of business processes.

3. Pilot testing and optimization

3.1 Testing at selected sites. Implement the new technique at one or more test sites of the enterprise to evaluate its effectiveness in real conditions. This will allow you to identify possible problems and make the necessary adjustments before large-scale implementation.

3.2 Process optimization. Based on the test results, optimize warehouse processes, including receiving, storing and shipping goods. Adapt inventory management methods, such as ABC analysis and XYZ analysis, to more accurately identify prioritized product groups.

4. Monitoring and control

4.1 Continuous monitoring. Introduce a system of continuous monitoring of the new inventory management system. Regularly analyze key performance indicators and audit the system.

4.2 Feedback. Collect feedback from employees and customers to assess satisfaction and identify potential issues.

5. Scaling and standardization

5.1 System scaling. Based on the results of pilot testing and monitoring, adjust the method and software. Gradually expand the implementation of the new method to all departments of the enterprise.

5.2 Documentation and standards. Develop detailed documentation on the new inventory management method, including standards and procedures. Ensure that documentation is available to all employees involved in inventory management.

6. Increase efficiency and competitiveness

6.1 Improving customer service. With more accurate and faster inventory management, improve the customer experience by reducing waiting times and improving the availability of goods.

6.2 Cost reduction. Optimizing inventory management will reduce storage and logistics costs, which will lead to an increase in the overall profitability of the enterprise.

The introduction of this method will allow TH Megapolis LLC to significantly improve inventory management, increase the efficiency of warehouse operations and customer satisfaction, as well as strengthen its competitive position in the market.

3.3 Assessment of the economic efficiency of the alternative method of inventory management in TH Megapolis LLC

The effectiveness of an inventory management system based on the principles of queuing theory is determined by a large number of different criteria, and the criteria may be different for different types of queuing systems. Depending on the model of the queuing system, the main characteristics of the system's functioning change.

Here are the indicators of the efficiency of the queuing system with failures and their designations:

– Likelihood of refusal of service P_{ref};

– the likelihood that the request will be served P_{serv};

– average number of occupied channels $\bar{n}_{occ}$ and the average number of available channels $\bar{n}_{av}$;

– channel occupancy rate k_{occ} and the share of available channels k_{av};

– average request service time $\bar{t}_{serv}$;

– average channel downtime $\bar{t}_{dt}$;

– Relative throughput of system q;

– absolute throughput of system A.

The listed criteria do not take into account the economic factor that is important when choosing the optimal parameters of the queuing system. One of the general economic indicators is economic efficiency:

$$E = P\ serv\lambda CT - G_l$$

where C is the average economic effect obtained when servicing one request; T is the time interval under consideration; G_l – the cost of losses in the system.

For queuing system with failures, the loss value is calculated using the formula:

$$G_l = \left(q_k \bar{n}_{occ} + q_y P\ ref\lambda + \ q_{nk} \bar{n}_{av}\right) T$$

where q_k - cost of operation of one channel of the system per unit of time; q_y – the cost of losses as a result of the withdrawal of requests from the system per unit of time; q_{nk} – Cost per unit of channel downtime.

Calculation of queuing system performance indicators with refusals:

Likelihood of refusal of service P_{ref} is determined by the probability that the request received for service will find all channels occupied, i.e. the system will be in the state of S_n. Hence:

$$P_{ref} = P_n = \frac{\rho^n}{n!} P_0$$

Find the probability that the request will be served P_{serv} . It is clear that $P_{serv} + P_{ref} = 1$. Hence $P_{serv} = 1 - P_{ref}$.

Let's find the average number $\bar{n}_{occ}$ occupied channels. This indicator is mathematically revived by the number of occupied channels. Therefore:

$$\bar{n}_{occ} = \sum_{k=1}^{n} kP_k$$

However, this formula is inconvenient for calculations. Let's get a simpler formula. In any queuing system, each request can be served by only one channel. Therefore, the average number of requests λ_0, serviced per unit of time is defined as the product of the average number of occupied channels $\bar{n}_{occ}$ and service flow density:

$$\lambda_0 = \bar{n}_{occ}\mu$$

Probability P_{serv} can be defined as the ratio of the flow density of serviced requests to the density of the flow of incoming requests:

$$P_{serv} = \frac{\lambda_0}{\lambda}$$

From the obtained ratios, we get $\bar{n}_{occ} = \rho P_{serv}$. Now the average number of available channels $\bar{n}_{av}$ is calculated as follows:

$$\bar{n}_{av} = n - \bar{n}_{occ} = n - \rho P_{serv}.$$

Channel occupancy rate k_{occ} – is the share of occupied channels:

$$k_{occ} = \bar{n}_{occ} / n$$

Share of available channels k_{av} is calculated according to the formula:

$$k_{av} = \bar{n}_{av} / n$$

Average time of order service by one channel:

$$\bar{t}serv = 1/\mu.$$

Let's determine the average downtime of channels $\bar{t}_{dt}$. For this purpose, let's introduce the probability $P_{зн}$ that an arbitrarily taken channel is busy servicing a request. This probability is the same for all channels and is calculated using the formula:

$$P_{зн} = {}^{n_{зн}}/_{n}$$

This probability can be determined by the formula

$$P_{3n} = \frac{\bar{t}serv}{\bar{t}serv + \bar{t}_{dt}}$$

Hence:

$$\bar{t}_{dt} = \bar{t}serv\frac{1 - P_{3n}}{P_{3n}} = \frac{1}{\mu}\frac{n - \overline{n_3}}{\bar{n}_3}$$

The relative throughput of the system q is the share of requests served:

$$q = {}^{\lambda_0}/_{\lambda} = P_{serv}\rho$$

Absolute throughput:

$$A = \lambda_0 = \lambda q = \lambda Pserv$$

where A – This is the number of requests served by the system per unit of time.

For a single-channel queuing system, the calculation of indicators is simplified:

$$P_0 = \frac{\mu}{\lambda + \mu}\ ;\ Pserv = \frac{\lambda}{\lambda + \mu};\ Pserv = q = \frac{\mu}{\lambda + \mu};\ A = \frac{\lambda\mu}{\lambda + \mu}$$

Consider the queuing system with waiting, i.e., with an unlimited queue length. For these systems, the incoming flow of requirements can be considered unlimited.

Suppose the queuing system consists of n channels (in our case, goods). The system is fed a stream of requests with a rate of λ. Each channel has the same service performance with a rate of μ. Each newly received request, having found all the channels busy, becomes a queue and stays in it until one of the channels is free.

Here are the main performance indicators of the queuing system:

The likelihood of a request being queued $Poч$:

$$Poч = \sum_{l=0}^{\infty} P_{n+l} = \frac{p^{n+1}}{n!\,(n-p)}P_0$$

Average number of requests in the service queue (average queue length $\bar{l}oч$):

$$\bar{l}oч = Poч\frac{n}{n-P} = \frac{p^{n+1}}{(n-7)!\,(n-p)^2}P_0$$

Average waiting time for a request in the queue $\bar{t}oч$:

$$\bar{t}oч = \frac{\bar{l}_0 ч}{\lambda}$$

Average request stay time queuing system $\bar{t}_{\text{смо}}$:

$$\bar{t}_{\text{смо}} = \bar{t}oч + \bar{t}serv = \frac{\bar{t}oч}{\lambda} + \frac{1}{\mu}$$

Average number of occupied and avaliable channels $\bar{n}_{occ}, \bar{n}_{av}$:

$$\bar{n}_{occ} = \frac{A}{\mu} = \frac{\lambda}{\mu} = p;\ \bar{n}_{av} = n - p$$

Channel occupancy rate k_{occ}:

$$k_{occ} = \frac{\bar{n}_{occ}}{n} = \frac{p}{n}$$

Average number of requests in the system $\bar{t}_{\text{смо}}$:

– $\bar{t}_{\text{смо}} = \bar{l}\text{оч} + \bar{h}_{occ} = \bar{l}\text{оч} + p$

Average time of service channels $\bar{t}_{dt}$:

$$\bar{t}_{occ} = \frac{1}{\mu}\frac{n - \overline{n_{occ}}}{n}$$

For a single-channel queuing system with a waiting formula, the following are greatly simplified:

$$P_0 = 1 - p;\ Poч = p^2;\ \bar{l}oч = \frac{p^2}{1-p};\ \bar{t}oч = \frac{p}{\mu(1-p)};\ \bar{t}cmo = \frac{1}{\mu-\lambda}.$$

The main activity of the company is wholesale and retail trade in goods. TH Megapolis LLC includes several divisions, such as warehouse complexes and retail outlets. To consider the use of the queuing system in inventory management, let's take a rack of a warehouse complex on which one product is placed.

Requests for goods are received continuously, in accordance with orders from customers or the internal needs of retail outlets. requests are processed using an automated management system, which functions as a single-channel queuing system with n = 1.

The responsibilities of warehouse employees who manage orders include:

– registration of received requests in the database;
– checking the availability of goods in the warehouse;
– preparation of goods for shipment or transfer to the trading floor;
– updating of inventory data in the management system;
– notification of customers about the status of their orders.

The working time of warehouse employees for processing requests is from 8 am to 8 pm, that is, 12 hours. The average processing time for one request is 15 minutes.

A warehouse queuing system is a waiting system, that is, a queuing system with an unlimited queue length. The main indicators of the system include:

– Average wait time, which is the amount of time a ticket spends in the queue before processing begins.
– average service time, that is, the time spent on processing one request.
– Ticket flow rate (λ), that is, the average number of requests received per unit of time.
– service intensity (μ), that is, the average number of requests processed per unit of time.

Intensity of the flow of requirements per unit of time (hour):

$$\lambda = {}^{6}/_{8} = 0{,}75$$

Average number of requests served per unit of time (hour):

$$\mu = {}^{1}/_{0{,}67} = 1{,}5$$

Channel load intensity:

$$\rho = {}^{\lambda}/_{\mu} = {}^{0{,}75}/_{1{,}5} = 0{,}5$$

This means that the service channel receives 0.75 requests in one hour. The channel is capable of serving 1.5 requests per hour. The calculated intensity of the channel load is 0.89.

The probability of an requests being queued:

$$P_{оч} = p^2 = 0{,}5^2 = 0{,}25$$

Average number of requests in the service queue:

$$\bar{t}_{оч} = \frac{p^2}{1-p} = \frac{0{,}25}{0{,}5} = 0{,}5$$

Average waiting time for a request in the queue:

$$\bar{t}_{оч} = \frac{p}{\mu(1-p)} = \frac{0{,}5}{1{,}5(1-0{,}5)} = 0{,}67$$

Average time of request stay in the system:

$$\bar{t}_{смо} = \frac{1}{\mu-\lambda} = \frac{1}{1{,}5-0{,}75} = 1{,}33$$

These indicators fully characterize the operation of the system. Indeed, when the flow of requests increases over 10 per day, it is necessary to expand the number of channels to 2 units or reduce the time of servicing one request.

The main factors of queuing system efficiency are:

– increase in service channels;
– reduction of service time;
– the time the request is in the queue.

In our opinion, the proposed method is much better and more effective than all currently existing inventory management systems. The implementation of an inventory management system based on the queuing theory in TH Megapolis LLC will allow:

– to increase the efficiency and accuracy of processing requests.
– reduce customer waiting time.
– optimize the use of warehouse resources.
– improve customer satisfaction by improving the quality and speed of service.

Continuous monitoring and analysis of the performance indicators of the inventory management system will allow you to identify and eliminate bottlenecks in a timely manner, ensuring the stable and efficient operation of the entire system.

The proposed method not only takes into account current inventory needs, but also provides flexibility and adaptability of the management system, allowing you to minimize delays in service and increase customer satisfaction. The introduction of queuing theory into inventory management contributes to a more efficient use of warehouse resources, cost reduction and improvement of the overall productivity of a trading enterprise.

To assess economic efficiency, we will choose 4 efficiency criteria:

– how much the average waiting time will decrease;

– how much the level of service for customers on orders will increase;

– how much the volume of stock in the warehouse will change;

– how much the inventory turnover will change.

Criterion 1. Average wait time.

Average waiting time directly affects the efficiency of the inventory management system and the overall efficiency of logistics operations. The proposed order management system, based on the queuing theory, allows for more accurate and efficient management of the flow of replenishment requests, which significantly reduces the time required to fulfill orders.

The average wait time in an inventory management system is the time interval during which a replenishment requisition waits to be processed and executed. This time directly affects the speed of replenishment and, therefore, the company's ability to meet demand in a timely manner.

Let's calculate the parameters of the average waiting time before and after the implementation of the inventory management system.

As discussed in Chapter 1, on average, sales units send about 95 requisitions to the warehouse per day, and of these requisitions, only about 90 are processed on the same day.

Thus, the existing inventory management system is characterized by the following parameters:

1. Intensity of the flow of requests (average flow):

$$\lambda = 90 \text{ (request flow per day).}$$

2. Intensity of service (average speed of processing requests)

$$\mu = 90 + \frac{95 - 90}{90} = 90{,}1 \text{ requests per day}$$

3. Average Wait Time (T):

$$T = \frac{\lambda}{\mu\,(\mu - \lambda)} = \frac{90}{90{,}1\,(90{,}1 - 90)} \approx 10 \text{ days.}$$

We consider this average waiting time unacceptable. It is necessary to ensure that all requests are fulfilled on the same day, even if individual employees have to stay late at work to do so. As a result, the real flow of requests will be not 90, but 95 requests per day, this is the key point. Of course, even in this case, some requests will still be processed the next day, moreover, the company will be able to plan the receipt of stocks more freely (for example, it will be possible not to rush to process non-urgent deliveries, and leave them for the next day), but an increase in the real flow and intensity of service will significantly reduce the waiting time.

Let's check if this is true. The new inventory management system will have the following parameters:

1. Intensity of the flow of requests (average flow):

$$\lambda = 95 \text{ (request flow per day).}$$

2. Intensity of service (average speed of processing requests)

$$\mu = 95 + \frac{125 - 95}{95} = 95{,}33 \text{ requests per day.}$$

3. Average Wait Time (T):

$$T = \frac{\lambda}{\mu\,(\mu - \lambda)} = \frac{95}{95{,}33\,(95{,}33 - 95)} \approx 3 \text{ days.}$$

Therefore, the average wait time values can be justified as follows.

Before the implementation of the system: with the intensity of the flow of requests λ = 90 requests per day and the processing speed of μ = 90.1 requests per day, the average waiting time is about 10 days.

After the implementation of the system: with a request flow rate of λ = 95 requests per day and a processing speed of μ = 95.33 requests per day, the average waiting time is reduced to about 3 days (Table 13).

Table 3 – Assessment of the effectiveness of the inventory management system by the criterion "Average waiting time»

Indicators	Before introduction of the queuing system	After the introduction of the queuing system	Effect
Average waiting time	Slow replenishment: Long waiting times for replenishment reduce the speed of order fulfillment	Reduced waiting times: Fast replenishment reduces lead times, improving timeliness.	
	10 days	3 days	70% reduction
Influencing factors	Limited forecasting methods: Seasonal fluctuations, marketing promotions, and other factors that affect demand are not taken into account.	Dynamic demand flow management: Order flows are processed in real time, allowing you to react instantly to changes in demand and supply conditions.	
	Lack of dynamic optimization: orders are calculated based on static data, which does not allow you to quickly respond to changes in demand and supply.	Service Channel Optimization: Increase the number of service channels for popular products, which reduces queue times.	
	Insufficient automation: Manual intervention is required to generate orders and track deliveries.	Fully automated: Manual intervention is reduced, speeding up the ticket process.	

Before the implementation of the proposed system, the average waiting time is about 10 days. This is due to the use of static data for forecasting and order generation, as well as insufficient automation of processes. After the implementation of an order management system based on the queuing theory, the average waiting time will be reduced to 3 days. This will be possible thanks to the dynamic management of order flows, optimization of the number of service channels and full automation of inventory management processes. As a result, the average waiting time will be reduced by 70%, which will significantly increase the efficiency and efficiency of inventory management.

Criterion 2. Service level.

The level of service reflects the company's ability to meet customer demand in a timely manner and in full. A high level of service directly affects customer satisfaction, loyalty and, ultimately, the competitiveness of the enterprise.

Prior to the implementation of the system:

Average number of requests per day (λ): 100 requests.

Average number of requests that are processed on the same day (μ_{before}): 90 requests.

Probability of meeting requests (service level) before implementation:

$$P_{before} = \frac{\lambda}{\mu_{before}} \times 100\% = \frac{90}{100} \times 100\% = 90\%.$$

After the implementation of the system:

Average number of requests per day (λ): 100 requests.

Average number of requests that are processed on the same day (μ_{after}): 95 requests.

Probability of meeting requests (service level) before implementation:

$$P_{after} = \frac{\lambda}{\mu_{after}} \times 100\% = \frac{95}{100} \times 100\% = 95\%.$$

Thus, the introduction of the queuing theory into the inventory management system will significantly increase this indicator due to more accurate and operational inventory management (Table 14).

Table 4 – Assessment of the effectiveness of the inventory management system according to the criterion "Service level"

Indicators	Before introduction of the queuing system	After the introduction of the queuing system	Effect
Service level	Slow replenishment: Long waiting times for replenishment reduce the speed of order fulfillment	Reduced waiting times: Fast replenishment reduces lead times, increasing timeliness.	
	80%	95%	15% increase
Influencing factors	Periodic shortages of goods in stock lead to non-fulfillment of customer orders.	Dynamic inventory management allows you to more accurately predict demand and replenish inventory in a timely manner.	
	Excess inventory creates problems with expiration dates and limits the ability to respond quickly to changes in demand.	Reduces the risk of deficit and excess inventory, ensuring that the right goods are available in the right quantity	

Prior to the implementation of the proposed system, the level of customer service is 80%. This is due to the lack of efficiency in replenishing stocks and frequent shortages of goods. After the implementation of an inventory management system based on the queuing theory, the service level will increase to 95%. This will be achieved by reducing waiting times, improving forecasting accuracy, and optimizing inventory management.

Criterion 3. Change in the volume of inventory in the warehouse.

The amount of inventory in the warehouse is a critical indicator of the effectiveness of inventory management. Maintaining optimal inventory levels minimizes storage costs and reduces the risks associated with stockouts or excess inventory. The introduction of the queuing theory into the inventory management system contributes to the optimization of the volume of stocks in the warehouse, making the system more flexible and adaptive to changes in demand

We can use standard statistical methods to estimate changes in inventories. Let's perform a calculation based on the change in the coefficient of variation in demand and lead time before and after the implementation of the system. Hereon out, all calculations are made for one item - "Wheat flour".

Source data:

Λ_{before} = 90 requests/day (before introduction);

Λ_{after} = 95 requests/day (after introduction);

M_{before} = 91,1 requests/day (before introduction);

M_{after} = 95,33 requests/day (after introduction);

T_{before} = 10 days;

T_{after} = 3 days;

CV = 1 (pre-implementation) and 0.3 (post-implementation)

replenishment time L = (let's be equal to 5 days).

Calculation of the volume of stocks **before the implementation of the system**:

Standard Deviation of Demand over Lead Time:

$$\sigma_d = \sqrt{L} \cdot \lambda \cdot CV = \sqrt{5} \cdot 90 \cdot 1 = 201{,}24\ units.$$

Average demand:

$$\lambda \cdot L = 90 \cdot 5 = 450\ units.$$

Average Stock:

$$Z_a = z \cdot \lambda \cdot L = 1{,}28 \cdot 450 = 576\ units.$$

where z is the value of the standard normal distribution for a given service level (z = 1.28 for service level = 90%).

Safety stock:

$$Z_b = z \cdot \sigma_d = 1{,}28 \cdot 201{,}24 = 257{,}6\ units.$$

Total Stock:

$$Z = Z_a + Z_b = 576 + 257.6 = 833{,}6\ units.$$

Calculation of the volume of stocks **after the implementation of the system**:

Standard Deviation of Demand over Lead Time:

$$\sigma_d = \sqrt{L} \cdot \lambda \cdot CV = \sqrt{5} \cdot 95 \cdot 0{,}3 = 63{,}7\ units.$$

Average demand:

$$\lambda \cdot L = 95 \cdot 5 = 475\ units.$$

Average Stock:

$$Z_a = z \cdot \lambda \cdot L = 1{,}28 \cdot 475 = 608\ units.$$

where z is the value of the standard normal distribution for a given service level (z = 1.28 for service level = 95%).

Safety stock:

$$Z_b = \text{z} \cdot \sigma_d = 1{,}28 \cdot 63{,}7 = 81{,}6\ units.$$

Total stock:

$$Z = Z_a + Z_b = 608 + 81{,}6 = 689{,}6\ units.$$

Thus

– in physical terms: before the introduction of the system, there were 833.6 units, and after – 689.6 units, which is 17.28% less than the initial stock

– in value terms: before the introduction of the system 384600 thousand rubles (the line "Inventories" in the balance sheet), and after

$$384600 \cdot (1 - 0{,}1728) = 318151\ \text{thousand. rub.}$$

(Table 15).

Table 5 – Assessment of the effectiveness of the inventory management system by the criterion "Volume of stocks in the warehouse"

Indicators	Before introduction of the queuing system	After the introduction of the queuing system	Effect
Stock, thousand rub.	384600	384600 * (1-0,1728) = 318151	20% decrease
Influencing factors	Due to the use of static forecasts, there is a risk of surplus accumulation, which leads to an increase in storage costs and the risk of spoilage of goods.	The system allows you to adapt to changes in demand in real time, which reduces the risk of over- and under-inventory.	
	Limited forecasting methods do not always allow for timely replenishment, which leads to shortages and the inability to meet demand.	Regular and timely replenishment reduces the need for large storage volumes, which reduces storage costs.	
	Inconsistent and untimely deliveries lead to fluctuations in inventory volume, which reduces the efficiency of warehouse space utilization.	The system allows you to consider seasonal fluctuations in demand and other external factors, which contributes to a more even and efficient inventory management.	

Before the introduction of the proposed system, the volume of stock in the warehouse averaged 384,600 thousand rubles due to the need to maintain large reserves due to insufficient forecasting accuracy and irregular replenishment of stocks. After the implementation of the inventory management system based on the queuing theory, the stock volume in the warehouse will be reduced by 20%, this is due to more accurate and dynamic inventory management, regular replenishment. In this way, the company will be able to reduce storage costs and reduce the risks associated with excess inventory, which will have a positive impact on the overall efficiency of the enterprise.

Criterion 4. Change in inventory turnover.

Inventory turnover is a key indicator of inventory management performance, reflecting how quickly goods turn into sales and replenish inventory. Improving inventory turnover is an important goal for businesses, as it helps optimize the use of resources and increase profits.

The current inventory turnover was calculated in paragraph 1.1 above.

Taking into account the implementation of an alternative inventory management system, let's calculate the inventory turnover ratio before and after:

– in 2023: 5096267 / [0,5 × (432795 + 383+384600+383)] = 12,46 turnovers.

– in 2023: 5096267 / [0,5 × (432795 + 383+318151+383)] = 13,55 turnovers.

Inventory turnover:

– in 2023: 365 / 12,46 = 29,29 days.

– в 2023-м году: 365 / 13,75 = 26,93 days.

Thus, the turnover is expected to accelerate from 12.46 to 13.55 turnovers per year (this is 8.75% more than before), or, accordingly, a reduction in the inventory turnover period from 29.29 to 26.93 days (that is, by 2.35 days). This effect is presented in Table 16.

Table 6 – Assessment of the effectiveness of the inventory management system by the criterion "Inventory turnover"

Indicators	Before introduction of the queuing system	After the introduction of the queuing system	Effect
Inventory turnover ratio, turnovers. per year	12,46	13,55	An increase of 1,09 turnovers per year, or 8,75%
Period of one turnover (inventory turnover period)	29,29	26,93	Deacrease of 2,35 days, or 17,28%
Influencing factors	Insufficient consideration of seasonal fluctuations, marketing promotions and other factors leads to a slow response to changes in demand, which slows down inventory turnover.	Big data analysis and the use of modern forecasting methods make it possible to more accurately predict demand and adapt to changes.	
	Inconsistent and untimely deliveries of goods reduce the ability to quickly update inventory and respond to changes in demand.	Dynamic inventory management allows you to react more flexibly to changes in demand and minimize the risk of over- or under-inventory.	
	Improper distribution of stocks and excessive purchases lead to a low turnover rate of goods and the inability to free up funds for new investments.	More efficient supply planning and optimization of logistics processes contribute to fast replenishment of stocks and faster turnover.	

Thus, within the scope of this study, an inventory management system based on the queuing theory was developed, which has the ability to calculate a wide range of parameters, such as the flow of requests, the probability of failure, the probability of service, the number of busy and free channels (shelves), service time, waiting time in queue, idle time, throughput, service efficiency, service level, probability of blocking, probability of overflow, the average number of requests in the system, and others.

The implementation of the queuing system significantly increases the manageability of the system, expands its functionality and flexibility. The practical implementation of this system allows you to optimize inventory management processes in the following ways.

1. Adaptive management of order thresholds.

If a product is in high demand and is purchased frequently, the system automatically increases the threshold quantity for ordering it. This allows you to replenish stocks in a timely manner and prevent shortages.

2. Assortment optimization.

Products that have low demand are not ordered until new demand data is available. The system generates notifications to suppliers about the low sales of goods and offers to replace them with a more popular assortment.

3. Supplier evaluation and adaptation.

In case the supplier has a high delivery speed, the system lowers the threshold for the order, which allows you to minimize storage volumes without the risk of shortages. Additional surveillance regimes are established for slow and unreliable suppliers, and in the event of non-compliance, their cooperation may be reviewed or terminated.

4. Taking into account seasonal fluctuations in demand.

The system predicts seasonal changes in demand, such as an increase in flour demand before Easter, and automatically increases orders for eligible items a week before the expected increase in demand. At the same time, sales data for previous years are taken into account.

Thus, thanks to the implementation of the queuing system, the inventory management system becomes more autonomous and efficient. The shelves automatically manage their contents, and the operator acts as an observer and problem solver, intervening only in case of unforeseen situations.

These changes contribute not only to an increase in the level of customer service, but also to a significant reduction in storage costs, an improvement in inventory turnover and an increase in the overall economic efficiency of the company.

After the implementation of an inventory management system based on the queuing theory, inventory turnover will accelerate by 8,75%. This increase indicates a faster conversion of goods into sales and a more efficient use of the company's resources.

Nothing definite can be said about the cost of the proposed system for the enterprise, but according to the estimates of the development of similar software solutions by other companies, it can be assumed that the development of the software solution itself will cost about 5.5 million rubles.

In addition, it will be necessary to equip the racks with an industrial vision system. It is proposed to choose industrial vision systems from the Russian manufacturer Delta Electronics complete with 60 cameras, 15 video controllers (one for every 4 cameras) and a video server (Figure 4).

Figure 4 – Delta Electronics Industrial Vision System DMV2000

In this case, employees will not need to enter the amount of remaining inventory into the system on their own, the system itself will "see" the contents of the rack, and we will be able to remind suppliers to bring the goods if the amount of goods on a particular rack is approaching a critical level. The cost of the industrial vision system will be another 3.5 million rubles.

The system being developed will be fully compatible with the existing accounting system, so additional costs for creating jobs or training personnel are not planned.

The total cost of implementing the system will be 9 million rubles.

If we assume with a certain degree of conditionality that all the company's inventories are trade inventories, then, taking into account the turnover, we can determine the expected amount of revenue: 5,289,913 * 1.104 = 5,840,064 thousand rubles.

Thus, the increase in revenue due to the acceleration of inventory turnover will amount to 550,150 thousand rubles, which corresponds to an increase in net profit in the amount of

54835 * (550150 / 5289913) = 5700 thousand rubles.

The expected payback period is 9000 / 5700 = 1.57 years, or 19.2 months.

Thus, the proposed inventory management system, based on the queuing theory, represents a promising solution for optimizing the company's activities. Cost-benefit analysis shows that the implementation of this system will bring significant benefits and pay off in a short time.

Taking into account the total cost of implementing the system in the amount of 9 million rubles and the expected increase in revenue due to the acceleration of inventory turnover, calculated in the amount of 550,150 thousand rubles, we can conclude that the company's net profit has increased significantly by 5,700 thousand rubles.

The expected payback period of the new system is 1.57 years, which corresponds to 19.2 months. This suggests that investments in the implementation of an inventory management system will pay off in the shortest possible time, and further use of the system will bring a stable financial result.

Thus, the proposed inventory management system is a cost-effective solution for the company, contributing to increasing its competitiveness and profitability.

CONCLUSION

On the basis of the study and in accordance with the goal and objectives of the study, the following conclusions and proposals can be made based on the results of the work.

The first chapter provides a detailed description of the company TH Megapolis LLC, including its structure, main economic indicators and features of the organization of work.

TH Megapolis LLC is a large wholesale and retail trade enterprise. The main forms of organization of the trading process include retail sales, online trade, distribution and catalog trading.

The formation of inventory stock in warehouses is driven by several factors. Firstly, possible changes in sales plans and fluctuations in demand require flexibility in inventory management. Secondly, the risks of supply delays from manufacturers and the detection of defective goods also impact inventory levels, necessitating the creation of reserves to minimize negative consequences.

The company has formed its own inventory management policy.

The inventory management system in TH Megapolis LLC is based on the use of 1C Trade Management 8 software, which operates on the basis of Wilson's formula. This system includes several key aspects aimed at organizing the trading process, ensuring the smooth functioning of the enterprise and meeting the needs of customers.

Assortment planning is based on the analysis of current demand, stock balances and the market situation, which allows the company to quickly respond to changes and maintain an optimal level of inventory.

The existing inventory management system has a number of drawbacks:

– limited forecasting methods;
– lack of dynamic optimization;
– insufficient automation;
– The inventory management system does not take into account the variety of goods.

As a result of these shortcomings, the company may face problems such as overloading racks, problems with expired expiration dates, or low-quality goods.

The second chapter reviews scientific research and publications related to stockpile management in order to determine the current state of knowledge in the field and to identify gaps that may be filled by the study.

International inventory management standards and practices are analyzed to understand what approaches and techniques are used internationally, and how they can be applied in the context of the organization under study.

Inventory management practices in Walmart, Amazon, Alibaba Group, JD.com, Zara, Procter & Gamble are considered

Based on a theory and analysis of international practices, requirements for an inventory management system are formulated. These requirements define what an inventory management system must do to be effective and meet the needs of the organization:

– prevention of the formation of excess stocks;
– ensuring the optimal level of inventory;
– use of order management models;
– the use of innovative technologies, algorithms and automation systems.

The third chapter proposes directions for improving inventory management, taking into account international standards and practices for TH Megapolis LLC.

An alternative method of inventory management based on the theory of queuing is proposed, which will improve the processes of planning and distribution of goods. The logic of the proposed method is as follows.

– Each shelf on the rack is a service channel. Most often, there is one product (or very similar commodity items) on the shelf. That is, the company will have the opportunity to manage service channels (for example, allocate another shelf for a hot product);
– Each channel can serve only one requirement at a time. When all channels are busy with service, new requests entering the system become queued;
– The flow of requirements for each service channel is the flow of requests to the inventory management system for a specific product;
– a request (request) is each individual request for the performance of some work or satisfaction of a need;

The application of the queuing theory to inventory management allows you to consider each item as a separate service channel, which greatly simplifies and structures the management process. Thus, we have an inventory management system that works as a queuing system and very, very many service channels, which involves the management of "Big Data".

Within the framework of the proposed method, the inventory management system is considered as serving the main activity of the company, including wholesale and retail trade.

This seems to be the best solution, since the queuing system produces an order of magnitude more control parameters than other inventory management systems: ticket flow, probability of failure, probability of service, number of busy channels, number of busy channels, service time, waiting in queue, idle time, throughput, service efficiency, service level, probability of blocking, probability of overflow, average number of requests in the system, etc.

In addition, there are plus several service scenarios (with failures, with queues, single-channel-multichannel, etc.). This means that management in such a system is more flexible and adaptive than in other systems. It is based on the analysis of "big data", and modern systems cope with this task without any problems.

It is shown that the proposed inventory management method is able to level out all four identified shortcomings of the existing inventory management system.

Disadvantage 1. Limited forecasting methods. The proposed inventory management method, based on the queuing theory, helps to correct the first drawback associated with limited forecasting methods by introducing more complex and flexible data analysis models.

Disadvantage 2. Lack of dynamic optimization. There is every reason to believe that the proposed inventory management method, based on the queuing theory, can effectively eliminate the second drawback, the lack of dynamic optimization, through the introduction of adaptive mechanisms and continuous monitoring of the state of inventories.

Disadvantage 3. Insufficient automation. In contrast, a queuing system can automatically generate orders, track deliveries, and update inventory levels based on current data, reducing the need for manual intervention and improving inventory management efficiency.

Disadvantage 4. The inventory management system does not take into account the variety of goods. This problem can also be solved in the queuing system, through a differentiated approach to the management of different categories of goods.

In our opinion, the proposed approach to inventory management is significantly more effective than all existing systems today. The implementation of a system based on the theory of queuing in the activities of TH Megapolis LLC involves the following advantages:

- improving the efficiency and accuracy of order processing;
- reducing customer waiting times;
- optimization of the use of warehouse resources;
- Increasing customer satisfaction by improving the quality and speed of service.

The proposed approach not only takes into account current inventory needs, but also provides flexibility and adaptability of the management system, which minimizes delays in service and increases customer satisfaction. Systematic monitoring and analysis of inventory management performance indicators will allow you to quickly identify and eliminate deficiencies, ensuring the stable and effective functioning of the entire system. The introduction of the queuing theory into inventory management contributes to a more efficient use of warehouse resources, cost reduction and improvement of the overall productivity of a trading enterprise.

Turnover is expected to accelerate from 12.46 to 13.55 turnovers per year (this is 8.75% more than before), or accordingly reduce the inventory turnover period from 29.29 to 26.93 days (i.e. by 2.35 days).

The total cost of implementing the system will be 9 million rubles, the expected payback period is 1.57 years, or 19.2 months. Thus, the proposed inventory management system is a cost-effective solution for the company, contributing to increasing its competitiveness and profitability.

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APPENDIX

Appendix 1.

Data from the balance sheet of TH Megapolis LLC for 2019-2023

Бухгалтерский баланс	Стр.	2019	2020	2021	2022	2023
АКТИВ						
I. ВНЕОБОРОТНЫЕ АКТИВЫ						
Нематериальные активы	1110	–	–	–	–	–
Результаты исследований и разработок	1120	–	–	–	–	–
Основные средства	1150	13961	10018	260562	187506	115140
Доходные вложения в материальные ценности	1160	–	–	–	–	–
Финансовые вложения	1170	–	–	–	–	–
Отложенные налоговые активы	1180	–	–	–	–	15435
Прочие внеоборотные активы	1190	–	–	–	–	–
Итого по разделу I	1100	13961	10018	260562	187506	130575
II. ОБОРОТНЫЕ АКТИВЫ						
Запасы	1210	736261	741312	631918	432795	384600
Налог на добавленную стоимость по приобретённым ценностям	1220	16053	5011	383	383	383
Дебиторская задолженность	1230	601600	588292	702069	588483	527123
Финансовые вложения (за исключением денежных эквивалентов)	1240	–	1327	1327	–	–
Денежные средства и денежные эквиваленты	1250	12153	8969	23992	27973	11440
Прочие оборотные активы	1260	3003	4501	47606	1300	1090
Итого по разделу II	1200	1369070	1349412	1407295	1050934	924636
БАЛАНС	1600	1383031	1359430	1667857	1238440	1055211
III. КАПИТАЛ И РЕЗЕРВЫ						
Уставный капитал (складочный капитал, уставный фонд, вклады товарищей)	1310	10	10	10	10	10
Собственные акции, выкупленные у акционеров	1320	–	–	–	–	–
Переоценка внеоборотных активов	1340	–	–	–	–	–
Добавочный капитал (без переоценки)	1350	–	–	–	–	–
Резервный капитал	1360	–	–	–	–	–
Нераспределенная прибыль (непокрытый убыток)	1370	222294	243311	283881	335986	390821
Итого по разделу III	1300	222304	243321	283891	335996	390831
IV. ДОЛГОСРОЧНЫЕ ОБЯЗАТЕЛЬСТВА						
Заемные средства	1410	478525	623518	483888	312809	213876
Отложенные налоговые обязательства	1420	–	–	3424	3206	18070
Оценочные обязательства	1430	–	–	–	–	–
Доходы будущих периодов	1440	–	–	–	–	–
Прочие обязательства	1450	–	–	264600	147000	–
Итого по разделу IV	1400	478525	623518	751912	463015	231946
V. КРАТКОСРОЧНЫЕ ОБЯЗАТЕЛЬСТВА						
Заемные средства	1510	92775	30975	39349	–	209337
Кредиторская задолженность	1520	589424	461613	590361	439429	145922
Доходы будущих периодов	1530	–	–	–	–	–
Оценочные обязательства	1540	–	–	–	–	–
Прочие обязательства	1550	3	3	2344	–	77175
Итого по разделу V	1500	682202	492591	632054	439429	432434
БАЛАНС	1700	1383031	1359430	1667857	1238440	1055211

Appendix 2.

Data from the statement of financial results of TH Megapolis LLC for 2020-2023

Отчет о финансовых результатах	Стр.	2020	2021	2022	2023
Выручка	2110	3553503	4222688	5031325	5289913
Прочие поступления	2115	–	–	–	–
Себестоимость продаж	2120	-3016065	-3601820	-4410418	-4547151
Валовая прибыль (убыток)	2100	537438	620868	620907	742762
Коммерческие расходы	2210	-371992	-446960	-494351	-549116
Управленческие расходы	2220	–	–	–	–
Прибыль (убыток) от продаж	2200	165446	173908	126556	193646
Доходы от участия в других организациях	2310	–	–	–	–
Проценты к получению	2320	–	–	–	–
Проценты к уплате	2330	-63549	-64224	-64188	-51086
Прочие доходы	2340	68151	19503	37866	44477
Прочие расходы	2350	-143659	-95562	-35103	-118493
Прибыль (убыток) до налогообложения	2300	26389	33625	65131	68544
Текущий налог на прибыль	2410	-5278	-6725	-13026	-13709
в т.ч. текущий налог на прибыль	2411	–	-6753	-13244	-14280
отложенный налог на прибыль	2412	–	–	218	571
в т.ч. постоянные налоговые обязательства (активы)	2421	–	–	–	–
Изменение отложенных налоговых обязательств	2430	–	–	–	–
Изменение отложенных налоговых активов	2450	–	–	–	–
Прочее	2460	-94	-28	–	–
Чистая прибыль (убыток)	2400	21017	26872	52105	54835
СПРАВОЧНО					
Результат от переоценки внеоборотных активов, не включаемый в чистую прибыль (убыток) периода	2510	–	–	–	–
Результат от прочих операций, не включаемый в чистую прибыль (убыток) периода	2520	–	13698	–	–
Совокупный финансовый результат периода	2500	21017	40570	52105	54835
Базовая прибыль (убыток) на акцию	2900	–	–	–	–
Разводненная прибыль (убыток) на акцию	2910	–	–	–	–

Appendix 3.

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Наименование показателей	2021	2022	2023	Изменения 2023 г. от		Темп роста 2023 к 2021, %
				2021	2022	
Выручка от продаж	4222688	5031325	5289913	1067225	258588	125,27
Себестоимость производственная	3601820	4410418	4547151	945331	136733	126,25
Себестоимость полная	4048780	4904769	5096267	1047487	191498	125,87
Прибыль валовая	620868	620907	742762	121894	121855	119,63
Прибыль от продаж	173908	126556	193646	19738	67090	111,35
Прибыль налогооблагаемая	33625	65131	68544	34919	3413	203,85
Прибыль чистая	26872	52105	54835	27963	2730	204,06
Рентабельность активов, %	0,89	1,79	2,39	1,50	0,60	268,54
Рентабельность продукции, %	4,30	2,58	3,80	-0,50	1,22	88,37
Рентабельность продаж, %	4,12	2,52	3,66	-0,46	1,14	88,83
Рентабельность собственного капитала, %	5,10	8,41	7,54	2,44	-0,87	147,84
Рентабельность оборотных активов, %	0,97	2,12	2,78	1,81	0,66	286,6
Рентабельность внеоборотных активов, %	9,93	11,63	17,24	7,31	5,61	173,62
Среднесписочная численность персонала, чел.	296	306	302	6	-4	102,03
Производительность труда, тыс. руб./чел.	14265,8	16442,24	17516,27	3250,43	1074,03	122,78
Среднегодовая стоимость основных производственных фондов	135290	224034	151323	16033	-72711	111,85
Фондоотдача, руб./руб.	31,21	22,46	34,96	3,75	12,5	112,02
Фондоемкость, руб./руб.	0,0320	0,0445	0,0286	-0,0030	-0,0160	89,27
Фондовооруженность, тыс.руб./чел.	457,06	732,14	501,07	44,01	-231,07	109,63
Оборачиваемость оборотных средств, об. в год	1,53	2,05	2,68	1,15	0,63	175,16
Продолжительность оборота оборотных средств, дней	238,56	178,05	136,19	-102,37	-41,86	57,09
Оборачиваемость запасов, об. в год	5,87	9,21	12,46	6,59	3,25	212,27
Продолжительность оборота запасов, дней	62,18	39,63	29,29	-32,89	-10,34	47,11
Оборачиваемость денежных средств, об. в год	256,22	193,64	268,43	12,21	74,79	104,77
Продолжительность оборота денежных средств, дней	1,43	1,89	1,36	-0,07	-0,53	95,44
Оборачиваемость дебиторской задолженности, об. в год	6,54	7,80	9,48	2,94	1,68	144,95
Продолжительность оборота дебиторской задолженности, дней	55,81	46,80	38,50	-17,31	-8,29	68,99

Наименование показателей	2021	2022	2023	Изменения 2023 г. от		Темп роста 2023 к 2021, %
				2021	2022	
Оборачиваемость кредиторской задолженности, об. в год	7,70	9,53	17,41	9,71	7,88	226,1
Продолжительность оборота кредиторской задолженности, дней	47,40	38,30	20,97	-26,44	-17,34	44,23
Оборачиваемость собственного капитала, об. в год	15,36	15,82	14,02	-1,34	-1,80	91,28
Продолжительность оборота собственного капитала, дней	23,76	23,07	26,03	2,27	2,96	109,56
Оборачиваемость активов, об. в год	1,39	1,73	2,31	0,92	0,58	166,19
Продолжительность оборота активов, дней	262,6	211,0	158,0	-104,6	-53,0	60,17
Коэффициент текущей ликвидности	2,227	2,392	2,138	-0,089	-0,254	96
Коэффициент быстрой ликвидности	2,226	2,391	2,137	-0,089	-0,254	96
Коэффициент абсолютной ликвидности	0,04	0,064	0,026	-0,014	-0,038	65
Общий показатель ликвидности баланса	0,855	0,933	1,178	0,323	0,245	137,78
Коэффициент обеспеченности собственными средствами	0,017	0,141	0,281	0,264	0,14	1652,94
Коэффициент финансовой независимости	0,17	0,27	0,37	0,2	0,1	217,65
Коэффициент финансовой зависимости	5,87	3,69	2,7	-3,17	-0,99	46
Коэффициент соотношения заемных и собственных средств	4,87	2,69	1,7	-3,17	-0,99	34,91
Коэффициент финансирования	0,21	0,37	0,59	0,38	0,22	280,95
Коэффициент покрытия	2,23	2,39	2,14	-0,09	-0,25	95,96
Коэффициент постоянного актива	0,92	0,56	0,33	-0,59	-0,23	35,87
Коэффициент финансовой устойчивости	0,62	0,65	0,59	-0,03	-0,06	95,16
Коэффициент обеспеченности запасов собственными источниками	1,23	1,41	1,28	0,05	-0,13	104,07