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Факультет аеронавігації, електроніки та телекомунікацій
Кафедра авіаційних комп’ютерно-інтегрованих комплексів

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач випускової кафедри
________ Віктор СИНЄГЛАЗОВ
“___”_______________2024 р.

КВАЛІФІКАЦІЙНА РОБОТА
(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ

“БАКАЛАВР”

Спеціальність 151 «Автоматизація та компю’терно-інтегровані технології»
Освітньо-професійна програма «Комп’ютерно-інтегровані технологічні процеси і виробництва»

Тема: Автоматизована система управління постачанням запчастин для авіаційного підприємства

Виконавець: студент групи КП-402 Гриценко Мирослав Володимирович
Керівник: кандидат технічних наук, професор Сергеєв Ігор Юрійович

Нормоконтролер: _________ Філяшкін М.К
(підпис)

Київ – 2024

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
Faculty of Aeronautics, Electronics and Telecommunications
Department of Aviation Computer-Integrated Complexes

PERMISSION TO DEFEND
Head of the department
________ Viktor SINEGLASOV
“___”_______________2024 p.

QUALIFICATION WORK
(EXPLANATORY NOTE)

GRADUATE OF AN EDUCATIONAL DEGREE

“ BACHELOR”

Speciality 151 «Automation and Computer-Integrated Technologies»
Educational-Professional Program: «Computer-Integrated Technological Processes and Production»

Theme: Automated spare parts supply management system for an aviation company

Performer: student of the group KP-402Ba Hrytsenko Myroslav Volodymyrovych

Supervisor: candidate of technical sciences, professor Ihor Yuriyovych Sergeyev

Normative Controller: _________ Filiashkin M.K
(signature)

Kyiv 2024

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Факультет аеронавігації, електроніки та телекомунікацій
Кафедра авіаційних комп'ютерно-інтегрованих комплексів
Освітній ступінь «Бакалавр»
Спеціальність 151 «Автоматизація та комп’ютерно-інтегровані технології»
Освітньо-професійна програма «Комп’ютерно-інтегровані технологічні процеси і виробництва»

ЗАТВЕРДЖУЮ
Завідувач кафедри, д.т.н., проф.
__Віктор СИНЄГЛАЗОВ
«___» ___________ 2024 р.

ЗАВДАННЯ

на виконання кваліфікаційної роботи здобувача вищої освіти

Гриценка Мирослава Володимировича

1. **Тема роботи:** «Автоматизована система управління постачанням запчастин для авіаційного підприємства».

2. **Термін виконання роботи** з 13.05.2024 р. по 3.06.2024 р.

3. **Вихідні дані до роботи:** розробка автоматизованої системи управління постачанням запчастин для авіаційного підприємства, з урахуванням інтеграції аналітичних інструментів для прогнозування попиту, оптимізації запасів та забезпечення безперебійної роботи технічного обслуговування літаків.

4. **Зміст пояснювальної записки** (перелік питань, що підлягають розробці):
   1. Аналіз існуючих систем управління постачанням запчастин на авіаційних підприємствах.
   2. Розробка концепції автоматизованої системи управління.
   3. Розробка алгоритмів прогнозування попиту на запчастини.
   4. Розробка рекомендацій щодо впровадження та використання системи на авіаційному підприємстві.

5. **Перелік обов’язкового графічного матеріалу:** презентаційний матеріал представлений у електронному та фізичному форматі, який містить процес проектування автоматизованої системи управління постачанням запчастин з описом її елементів.

6. **Календарний план-графік**

№ п/п	Завдання	Термін виконання	Відмітка про виконнання
1.	Отримання завдання	13.05.2024 - 13.05.2024	
2.	Формування мети та основних завдань дослідження	13.05.2024-14.05.2024	
3.	Аналіз існуючих систем управління постачанням запчастин	14.05.2024-16.05.2024	
4.	Формулювання проблеми оптимізації процесу постачання	16.05.2024-20.05.2024	
5.	Розробка архітектури системи та її функціональної можливості	20.05.2024-22.05.2024	
6.	Моделювання процесів управління запасами в MATLAB	22.05.2024-28.05.2024	
7.	Підготовка звіту та презентаційних матеріалів	29.05.2024-3.06.2024	

7. **Дата видачі завдання** “13” травня 2023

Керівник: ______________________________ Сергеєв І.Ю

Завдання прийняв до виконання _________________________ Гриценко М.В.

NATIONAL AVIATION UNIVERSITY

Faculty of Air Navigation, Electronics and Telecommunications
Department of Aviation Computer-Integrated Complexes
Educational Degree "Bachelor"
Specialization: 151 “Automation and Computer-Integrated Technologies”
Educational-Professional Program: “Computer-Integrated Technological Processes and Production”

APPROVED BY
Head of Department,
Professor Dr. of Sc.
___________SINEGLASOV Viktor
«___» ____________ 2024 р.

TASK

for the bachelor degree thesis

Hrytsenko Myroslav Volodymyrovych

1. **Theme of the project:** «Automated spare parts supply management system for an aviation company».
2. **Term of work performance:** from 13.05.2024 to 3.06.2024.
3. **Output data to the project (work):** development of an automated spare parts supply management system for an aviation company, taking into account the integration of analytical tools for demand forecasting, inventory optimization, and ensuring the smooth operation of aircraft maintenance.
4. **Contents of the explanatory note (list of questions to be developed)**:
    1. Analysis of existing spare parts supply management systems at aviation enterprises.
    2. Development of the concept of an automated control system.
    3. Development of algorithms for forecasting the demand for spare parts.
    4. Development of recommendations for the implementation and use of the system at the aviation enterprise.

5. **List of compulsory graphic material:** the presentation material is presented in electronic and physical formats, containing the process of designing an automated spare parts supply management system with a description of its elements.

6. **Planned schedule:**

№	Task	Execution term	Execution mark
1.	Task receiving	13.05.2024 - 13.05.2024	
2.	Formation of the purpose and main objectives of the study	13.05.2024-14.05.2024	
3.	Analysis of existing spare parts supply management systems	14.05.2024-16.05.2024	
4.	Formulating the problem of optimizing the supply process	16.05.2024-20.05.2024	
5.	Development of the system architecture and its functionality	20.05.2024-22.05.2024	
6.	Modeling of inventory management processes in MATLAB	22.05.2024-28.05.2024	
7.	Preparation of the report and presentation materials	29.05.2024-3.06.2024	

7. **Date of task receiving:** “13” may 2023

Diploma thesis supervisor: ____________________________ Sergeyev Ihor

Issued task accepted _________________________________ Hrytsenko Myroslav

РЕФЕРАТ

Пояснювальна записка до дипломної роботи «Автоматизована система управління постачанням запчастин для авіаційного підприємства»: 66 сторінки, 10 рисунків, 2 таблиці, 10 джерел .

АВТОМАТИЗОВАНА СИСТЕМА, УПРАВЛІННЯ ЗАПАСАМИ, ПОСТАЧАННЯ ЗАПЧАСТИН, АВІАЦІЙНЕ ПІДПРИЄМСТВО, ПРОГНОЗУВАННЯ ПОПИТУ, ОПТИМІЗАЦІЯ.

Об’єкт дослідження – процес управління постачанням запчастин для авіаційного підприємства.

Мета дипломної роботи – аналіз та розробка автоматизованої системи управління постачанням запчастин, яка підвищить ефективність управління запасами, знизить витрати та забезпечить безперебійну роботу авіаційного підприємства.

Метод дослідження – аналіз існуючих систем управління запасами, розробка та застосування алгоритмів прогнозування попиту та управління запасами, моделювання процесів в середовищі MATLAB.

У процесі роботи було проведено аналіз існуючих систем управління постачанням запчастин, визначено їхні недоліки та можливості для вдосконалення. Розроблено алгоритми прогнозування попиту та управління запасами, які було реалізовано у середовищі MATLAB. Створено кілька графіків для візуалізації поточного стану запасів, прогнозованих потреб та історичних даних з лінією тренду.

Результати роботи можуть бути використані для впровадження автоматизованої системи управління постачанням запчастин на авіаційних підприємствах. Така система дозволить покращити ефективність управління запасами, знизити витрати на їх утримання та підвищити рівень обслуговування клієнтів.

Розробка коду та моделювання процесів здійснювались за допомогою середовища MATLAB.

ABSTRACT

Explanatory note to the diploma work “ Automated spare parts supply management system for an aviation company ”: 66 pages, 12 figures, 2 tables, 10 sources.

AUTOMATED SYSTEM, INVENTORY MANAGEMENT, SPARE PARTS SUPPLY, AVIATION ENTERPRISE, DEMAND FORECASTING, OPTIMIZATION.

The object of research is the process of managing the supply of spare parts for an aviation company.

The purpose of the thesis is to analyze and develop an automated spare parts supply management system that will increase the efficiency of inventory management, reduce costs and ensure the smooth operation of an aviation enterprise.

Research method - analysis of existing inventory management systems, development and application of demand forecasting and inventory management algorithms, process modeling in MATLAB.

In the course of work, the existing spare parts supply management systems were analyzed, their shortcomings and opportunities for improvement were identified. Algorithms for demand forecasting and inventory management were developed and implemented in MATLAB. Several graphs were created to visualize the current state of inventory, projected needs, and historical data with a trend line.

The results of the work can be used to implement an automated spare parts supply management system at aviation enterprises. Such a system will improve the efficiency of inventory management, reduce inventory maintenance costs, and improve customer service.

Code development and process modeling were carried out using MATLAB.

CONTENT

LIST OF TERMS, ABBREVIATIONS AND TERMS

UAV — Unmanned Aerial Vehicles;

AI — Artificial Intelligence;

IoT — Internet of Things;

PC — Personal Computer;

ERP — Enterprise Resource Planning;

CRM — Customer Relationship Management;

SCM — Supply Chain Management;

API — Application Programming Interface;

U.S. — United States.

INTRODUCTION

The aviation industry, as is known, is one of the most complex and crucial in the modern world. Its role in ensuring international connectivity, economic development, social integration, as well as in transporting passengers, cargo, and supporting military operations, is extremely significant. However, the successful operation and safety of aviation infrastructure depend on many factors, and among the most important is effective supply chain management for aviation company.

The aviation industry has made significant progress since its inception in the early 20th century. The invention of the airplane by the Wright brothers in 1903 marked the starting point for aviation development. Since then, the aviation industry has gone through several key stages of development, including military aircraft during the First and Second World Wars, the development of commercial airlines in the 1950s, the introduction of jet aircraft, and modern aviation technologies.

In the past, aviation was primarily restricted to military and experimental purposes. The early airplanes were primitive, made of wood and fabric, with limited flight capabilities. During World War I, aviation began to be actively used for reconnaissance and combat, leading to significant progress in technologies and tactics. In the interwar period, commercial aviation began to develop with the introduction of the first passenger flights, although this was only accessible to a few.

Today, the aviation industry is a high-tech and global sector. Modern aircraft can transport hundreds of passengers over long distances at high speeds and comfort. The aviation industry comprises many components, including aircraft manufacturing, maintenance and repair, airports, airlines, and regulatory bodies. Advanced technologies such as composite materials, avionics, fuel-efficient engines, and flight management systems have significantly improved the safety, efficiency, and environmental sustainability of flights. Automation and digital technologies also play a crucial role in modern aviation. Air traffic management systems, automated passenger and baggage handling systems, as well as advanced fleet management and route planning information systems, allow for significant efficiency gains and cost reduction.

The future of aviation promises even more innovations and advancements. The development of new technologies such as electric and hybrid engines aims to reduce dependence on fossil fuels and lower carbon dioxide emissions. Aviation companies are also working on the development of next-generation supersonic aircraft, which could significantly reduce flight times between continents. Unmanned aerial vehicles (UAVs) and drones are becoming increasingly common in civilian aviation, providing new opportunities for logistics, monitoring, and rescue operations. In the future, we can expect the integration of autonomous aircraft and more intelligent air traffic management systems, which will reduce human error and enhance flight safety.

The aviation industry is one of the most important components of modern global economic and social life. Its ability to quickly transport people and goods over long distances promotes globalization, facilitates international trade, and fosters the development of tourism and cultural exchange. Aviation connects distant regions, allowing economies of different countries to integrate into the global market. Additionally, aviation plays a key role in security by enabling rapid response to emergencies, delivery of humanitarian aid, and ensuring national security.

Today, the aviation industry faces numerous challenges, including increasing competition, the need to enhance flight safety, requirements for reducing environmental impact, and ensuring a high level of passenger service. Successfully overcoming these challenges is possible only through the implementation of advanced technologies and automation in all aspects of aviation enterprises' activities.

The emergence of supply chain management systems for the aviation industry traces its roots back to the very inception of aviation. The first flying aircraft created a need for necessary spare parts for maintenance and repair. In the initial stages, these were simple inventory management systems, primarily based on manual procedures and the expertise of technical specialists. Automation is a key element in the modernization and enhancement of efficiency across various industries, including aviation. From its early steps in the 20th century, when automation was just beginning to be applied to ease manual labor, to the present stage, where it is an integral part of all processes, automation has come a long way. Modern automation technologies encompass a wide range of systems, from automated production lines to complex logistics and supply chain management systems.

In the context of the aviation industry, automation plays a crucial role in ensuring reliability, safety, and economic efficiency. Automated management systems are used for flight planning, aircraft condition monitoring, maintenance and repair management, as well as for supply chain optimization. Progress in automation allows aviation enterprises to quickly adapt to market changes, improve customer service levels, and reduce operational costs.

The history of automation began with the emergence of the first mechanized systems, which significantly reduced manual labor costs and increased productivity. With the development of electronics and computing technology, automation took on new forms, including the introduction of programmable logic controllers (PLCs), microprocessor-based control systems, and integrated information systems. In modern times, automation involves the use of artificial intelligence, big data, and the Internet of Things (IoT), providing even greater flexibility and efficiency in processes.

Indeed, the aviation industry is a vital part of the modern world, fostering economic growth, international trade, and cultural exchange. It has undergone significant progress since its inception and continues to evolve thanks to advanced technologies and innovations. The future of aviation promises even more changes and opportunities, making the world even more interconnected and accessible to all. Automation and innovation will play a key role in this development, ensuring even greater efficiency, safety, and resilience of aviation operations.

CHAPTER 1
THEORETICAL OVERVIEW

1.1. Research objective

The aim of this study is to investigate, analyze, and assess supply chain management systems for aviation enterprises, as well as identify the most pressing challenges in this field. Additionally, we will conduct a review of existing software used for supply management automation, examining its advantages and disadvantages. Specifically, the research aims to evaluate the potential benefits of implementing such systems, including increased productivity, cost reduction, improved customer service, and risk mitigation. The study also examines current trends and challenges in the automation of spare parts supply in the aviation industry.

The research tasks include:

– Current State Analysis: Conduct a detailed analysis of existing supply chain management systems for aviation enterprises to identify their advantages, disadvantages, and opportunities for improvement.
– Identification of Priority Areas: Determine the most critical aspects of supply management that require immediate enhancement and optimization.
– Study of Current Issues: Investigate the current challenges and problems faced by aviation enterprises in spare parts supply management.
– Development of Improvement Proposals: Based on the analysis conducted, propose specific recommendations and strategies for improving spare parts supply management systems.
– Assessment of Potential Impact: Analyze the potential impact of the proposed recommendations on the efficiency and effectiveness of spare parts supply management for aviation enterprises.

Thus, this work aims to address current supply management issues in the aviation industry and provide specific practical recommendations for implementing effective technological solutions that will enhance competitiveness and success. Additionally, this study aims to explore and analyze various approaches and strategies for spare parts supply management in the aviation sector, as well as develop recommendations for improving the efficiency and reliability of these systems.

1.2. Review of approaches to spare parts supply management for aviation company

Reviewing approaches to spare parts supply management for aviation enterprises involves studying various strategies, methods, and practices used in this field. When analyzing literature and practical experience in this area, several main approaches and practices for effective aviation spare parts supply chain management can be identified. Let's examine each of them in detail.

The first approach is strategic management. Strategic supply management in the aviation industry involves developing precise strategies and plans aimed at optimizing spare parts supply management. This includes supplier identification, exploring new opportunities for supply chain optimization, and establishing long-term partnerships with key suppliers. The advantage of this approach is the ability to adapt to changes and implement strategies that effectively manage the supply and maintain production stability.

This approach to supply management focuses on developing and implementing strategies aimed at achieving long-term goals and increasing the organization's competitiveness. The main idea is to integrate spare parts supply as a component of strategic management within the enterprise.

The main aspects of strategic spare parts management include:

– Developing a supply strategy: this includes defining strategic goals, analyzing the market and competitors, and identifying preferences and needs for spare parts to ensure long-term success.
– Strategic planning: Developing plans and strategies to optimize spare parts supply, including supplier selection, risk management, and supply chain sustainability.
– Strategic supplier partnerships: establishing long-term partnerships with key suppliers, jointly planning and collaborating to achieve strategic goals.

- Strategic innovation: introduction of new technologies, management methods and innovative approaches to increase efficiency and competitiveness in the spare parts supply industry.
- Monitoring and evaluation: continuous monitoring and evaluation of the results of strategic supply management, making adjustments to achieve strategic goals.

Strategic spare parts management allows businesses to use resources efficiently, reduce costs and risks, improve the quality and efficiency of supply, and create competitive advantages in the market.

Inventory management is another important aspect of spare parts supply management for aviation enterprises. This approach is aimed at efficiently managing inventory to ensure the proper level of stocks and avoid disruptions in production or aircraft operation. To achieve this goal, inventory optimization methods are applied, such as the economic order quantity model and demand forecasting methods, which allow for effective inventory management and reduction of holding costs.

Inventory management, or inventory control as it's also known, is the process of planning, coordinating, and overseeing the stocks of goods or materials in warehouses or manufacturing facilities. The primary goal of inventory management is to efficiently utilize resources, ensure the proper level of inventory for uninterrupted production or service provision, and avoid unnecessary accumulation of stocks, which can lead to losses.

The main aspects of inventory management include:

- Inventory planning: this involves forecasting demand for goods or materials, determining optimal inventory levels to support production or customer service, and selecting inventory management strategies.
- Ordering and receiving goods: managing the process of ordering and receiving goods includes identifying needs, selecting suppliers, placing orders, quality control, and receiving goods into inventory.
- Storage and placement: organizing efficient storage and placement of goods in the warehouse to ensure quick access, safety, and minimize losses.

- Inventory control and tracking: this involves continuous monitoring of inventory levels, identifying and addressing risks of shortages or excess inventory, and keeping track of inventory in production and warehouses.
- Optimization and analysis: continuous improvement of inventory management processes through analysis of results, identifying and implementing optimal strategies and management methods.

Inventory management is a crucial component of the supply chain and production process in business, as it directly impacts resource efficiency and customer satisfaction.

Supply chain and logistics management is also a key element in spare parts supply management. This approach focuses on optimizing supply and logistics processes, including developing efficient delivery schemes, selecting optimal routes and transportation methods, and implementing tracking and monitoring technologies. This ensures the fast and seamless delivery of spare parts to production or service facilities.

Supply chain and logistics management is a set of strategies, processes, and methods aimed at optimizing the movement of goods from suppliers to end consumers to ensure efficiency, reliability, and timeliness of deliveries.

The main aspects of supply chain and logistics management include:

- Planning and coordination: this involves developing supply strategies, selecting suppliers, planning for the needs of goods or materials, and coordinating actions among different participants in the supply chain.
- Procurement and supply: managing the procurement process includes selecting suppliers, negotiating contracts, placing orders, and ensuring the quality of supplied goods.
- Transportation and warehousing: organizing the movement of goods from suppliers to warehouses or end consumers using transportation methods and appropriately storing goods in warehouses.
- Order processing and fulfillment: this involves processing customer orders, selecting goods from the warehouse, preparing them for shipment, and delivering orders to end consumers.

- Monitoring and analysis: continuously tracking the movement of goods, analyzing the efficiency and timeliness of deliveries, identifying and resolving issues in the supply chain to enhance its overall efficiency and effectiveness.

Supply chain and logistics management plays a crucial role in the efficient functioning of a business, enabling the seamless delivery of goods or services, reducing costs, and optimizing production and customer service processes.

Next is technologies and information systems. Technologies and information systems play a vital role in modern spare parts supply management. This approach involves using advanced software and innovations to automate and optimize spare parts supply management. It includes the implementation of inventory management software, monitoring and data analysis systems, and the application of artificial intelligence technologies for demand forecasting and supply chain optimization.

Technology and information systems play a key role in modern spare parts supply chain management for aviation enterprises. They provide automation and optimization of processes, enabling companies to ensure timely deliveries, reduce costs, and increase overall supply chain management efficiency.

Here are some aspects of technologies and information systems used in this field:

- Inventory Management Software: The use of specialized software allows the automation of inventory planning, demand forecasting, supply chain management, and warehouse accounting processes. Such systems enable effective inventory level management, avoiding supply disruptions, and reducing inventory holding costs.
- Monitoring and Data Analysis Systems: The large volumes of data generated in the supply chain management process can be efficiently processed using specialized monitoring and data analysis systems. These systems allow tracking of goods movement, identifying demand trends, responding promptly to market changes, and making informed decisions.
- Application of Artificial Intelligence (AI): Utilizing machine learning algorithms and data analysis improves demand forecasting, optimizes inventory distribution, plans supplies, and reduces risks in supply chain management. AI

can be used for decision-making automation, pattern recognition in data, and finding optimal solutions.

- Internet of Things (IoT): The application of IoT in supply management enables remote monitoring of inventory status, tracking the location of goods, performing predictive maintenance of equipment, and automating warehouse management processes.
- Cloud Technologies: The use of cloud services for data storage and processing provides enterprises access to powerful computing resources, as well as flexibility and scalability in supply chain management.

These technologies and information systems help aviation enterprises improve the efficiency of spare parts supply management, reduce costs and risks, and enhance customer service levels. Risk management strategies are a key element of effective spare parts supply management for aviation enterprises. This approach focuses on identifying and managing risks associated with the supply chain of spare parts. During risk identification, a broad range of potential hazards is considered, including market changes, political or economic turbulence, technical issues, and more. Once risks are identified, they are assessed based on their likelihood of occurrence and their impact on business processes.

Strategies and plans are developed for risk management, including crisis management plans and measures to mitigate the impacts of risks. This is followed by systematic risk monitoring and analysis of their impact on business processes to adapt risk management strategies to new circumstances. Particular attention is given to ensuring supply chain continuity during crises, which may include developing emergency recovery plans and securing alternative supply sources.

Here are some key aspects of risk management strategies (fig.1.1.):

- Risk Identification: The first step in risk management is to identify all potential risks that may arise in the supply chain of spare parts. This includes analyzing both external and internal factors that could affect the supply chain, such as changes in market conditions, political or economic turbulence, technical or technological issues, and more.

– Risk Assessment: After identifying the risks, they are evaluated considering their likelihood and impact on business processes. This allows companies to focus on the most significant and probable risks that could occur in the supply chain.
– Risk Management: Once the risks are assessed, strategies and plans are developed to manage them. This can include measures to minimize the impact of risks, creating alternative action plans for crisis situations, and negotiating agreements and contracts with suppliers that account for risks and establish the responsibilities of the parties involved.
– Monitoring and Analysis: An effective risk management strategy involves systematic monitoring of risks and their impact on business processes. This allows for timely detection of changes in the risk environment and adaptation of risk management strategies according to new circumstances.
– Ensuring Supply Continuity: Particular attention is given to ensuring supply continuity during crisis situations. This may involve developing recovery plans for emergencies, securing alternative supply sources, and creating reserve stocks.

Fig.1.1. Key aspects of risk management strategies

Risk management strategies help aviation enterprises effectively respond to unforeseen events and ensure continuity in spare parts supply, which is crucial for ensuring stability and success in business. These approaches are key to efficient spare parts supply management for aviation enterprises. Thorough study and analysis of these approaches will help identify the most optimal strategies and methods for a specific aviation enterprise.

1.3. Supply chain planning

Supply chain planning for spare parts is a complex, integrated process aimed at ensuring the competitiveness of the supply chain by reducing costs and improving customer service, meeting their needs for quality services and efficient resource management. This is a comprehensive process of planning, coordinating, and controlling all actions aimed at ensuring the proper supply of spare parts for aviation systems, apparatus, and equipment. This process encompasses every stage of the spare parts lifecycle, from selection and procurement to warehouse storage and use in aircraft maintenance and repair.

Key components in strategic supply chain planning are (fig. 1.2.):

- Human Resources (labor market, level of knowledge, competencies);
- Organizational and Network Solutions (network configuration of supply chains, organizational structure of supply chain management, production and logistics capacities, etc.);
- Technologies and Processes (availability, state of the service organizations market, outsourcing, innovations);
- Financial Resources (sufficiency of funds for the implementation of the supply chain planning process).

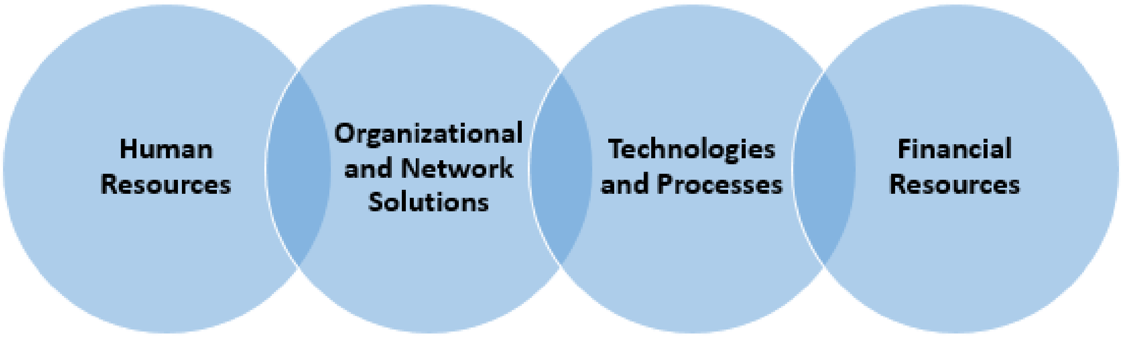


Fig. 1.2. Key components in strategic supply chain planning

Traditionally, the goal of supply chain planning is to find the optimal allocation of various functions across a defined set of resources, based on a certain criterion, typically the maximization of profitability. However, as the number of supply chain objectives increases, the diversity of possible allocation options for functions and business processes across resources also grows.

One of the main drawbacks of supply chain planning models is the lack of a feedback system. Planning is complicated by the uncertainty of the conditions under which the activity takes place. On the other hand, business processes in the supply chain are subject to constant changes from the initial plans due to the influence of various objective and subjective factors from the external and internal environments.

There are a number of criteria that need to be considered when planning supply chains, table 1.1.

Table 1.1.

Criteria for planning

Requirement	Characteristic
Implementation	The plan must be implemented in the conditions of real reality
Goal attainment	The plan should ensure the achievement of the set goal
Analyzeability	The plan and its structural elements

	must be subjected to deep analysis
Regulation	The plan should be able to make adjustments
Controllability	The plan as a whole and its sections must be subject to control by executors and customers
Synchronization	The plan must coincide with the specified implementation dates in reality

The main goal of managing spare parts supply is to ensure uninterrupted maintenance of aviation assets and support seamless operation of aviation enterprises in the dynamic environment of the global market. When forming the strategic supply chain plan, the main task is to balance key performance indicators of the chain, overall costs, and service level. This is necessary to assess the potential for improving service quality in conditions of cost constraints across the entire supply chain. Supply chain planning is aimed at making decisions regarding resource allocation and coordination of actions by chain participants. It is necessary to carefully configure the planning system to effectively control and reduce risks.

1.4. Innovative solutions for spare parts management in the aviation industry

Automation in spare parts management for aviation enterprises involves the use of modern technologies and software solutions to automate and optimize the processes of procurement, storage, supply, and utilization of parts for maintenance and repair of aviation equipment. This automation ensures speed, accuracy, and efficiency in inventory management, allowing for cost reduction and increased productivity.

The history of automation in manufacturing spare parts has many stages, with one of the key examples being the case of the automobile company Ford. In 1913, Henry Ford introduced assembly line production at his factory in Detroit, USA. This innovative approach increased production speed and reduced the cost of cars, making them accessible to a wide range of consumers. By using a moving assembly line, workers could perform individual operations on the production line, leading to increased productivity and production quality.

One of the key innovators in the aviation industry, akin to Henry Ford in the automotive industry, was Donald Douglas. He was known for his significant contributions to aviation manufacturing, particularly in the realm of mass-producing aircraft. Donald Douglas founded the Douglas Aircraft Company in 1921, which was one of the largest aircraft manufacturers in the world at the time. Throughout his career, he developed several revolutionary aircraft models and introduced innovative production methods.

One of Douglas's most notable contributions was the implementation of assembly line production in the aviation industry. He utilized innovative mass production methods to increase productivity and reduce production costs of aircraft. This allowed the Douglas company to rapidly deliver large batches of aircraft to the military and civilian airlines.

Thus, Donald Douglas can be considered an innovator in the aviation industry, much like Henry Ford was a pioneer in the automotive industry. His contributions to aircraft manufacturing and the implementation of production methods significantly influenced the development of the aviation industry.

In the modern aviation industry, automation in spare parts management plays a critical role in ensuring uninterrupted and efficient aircraft maintenance. For example, large airlines utilize specialized software systems to automate inventory management processes, allowing for accurate forecasting of spare parts demand, optimization of warehouse operations, and timely ordering of necessary components.

Furthermore, advanced technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI) are employed in the aviation industry for real-time tracking and monitoring of spare parts. For instance, sensors embedded directly into aircraft components can track various parameters such as temperature, pressure, humidity, etc. These sensor data are transmitted to the central inventory management system via the IoT network.

The Internet of Things (IoT) is a network of physical devices equipped with sensors, software, and capable of interacting and exchanging data over the Internet without direct human intervention. These devices can be embedded in various objects, ranging from household appliances like refrigerators and traffic lights to industrial equipment, automobiles, and aviation equipment.

The IoT network enables data collection from a vast number of sources and real-time transmission of this data to the central system for processing and analysis. This opens up numerous possibilities for monitoring and managing various processes, including inventory management, environmental monitoring, tracking of goods movement, and much more. In the context of the aviation industry, the IoT network can be used to monitor the condition of aircraft technical equipment, detect and diagnose faults, track the location of spare parts, and much more. This helps airlines ensure uninterrupted and efficient operation of their equipment, enhances flight safety, and enables efficient resource utilization.

As for Artificial Intelligence, it is used to analyze this data and detect any abnormal or suspicious changes in the condition of spare parts. For example, based on a large volume of data, artificial intelligence can forecast future maintenance costs, calculate the optimal level of inventory, and identify technical faults at early stages. The application of such advanced technologies allows aviation enterprises to promptly respond to any issues and prevent emergencies, thus ensuring a higher level of safety and reliability of aviation equipment.

1.5. Overview of existing spare parts supply management systems for aviation companies

Reviewing existing spare parts supply management systems for aviation enterprises allows for a better understanding of the variety of approaches, methods, and technologies used in this industry. Here's a more detailed overview of existing systems:

1. Traditional inventory management systems:
   - These systems rely on manual inventory management methods, such as Excel spreadsheets or manual journals.
   - They may be limited in terms of automation and efficiency since they do not utilize modern technologies to optimize inventory management processes.

- Typically used in smaller enterprises or in cases where more advanced systems are not feasible.

2. ERP Systems (Enterprise Resource Planning):
   - These systems integrate supply chain management with other business functions such as finance, accounting, and production.
   - They provide centralized information management and automate many routine tasks, facilitating coordination between departments.
   - However, some ERP systems can be expensive to implement and maintain, and may not always fully address the specific needs of the aviation industry.
3. Specialized Supply Chain Management Systems:
   - These systems are specifically designed to address the needs of aviation enterprises in managing spare parts supply.
   - They may include functions specific to the aviation industry, such as tracking safety-related spare parts or considering regulatory requirements.
   - These systems may be more flexible and adaptable to the specific needs of the enterprise compared to general ERP systems.
4. Innovative Technologies:
   - Modern technologies such as IoT and AI are used to enhance spare parts supply management processes.
   - IoT enables real-time tracking of spare parts status through embedded sensors, facilitating responsiveness to needs and maintenance planning.
   - AI can be utilized for analyzing large volumes of data and forecasting spare parts demand, allowing for inventory optimization and cost reduction.

I suggest taking a closer look at ERP systems. There are many software products that can be used to automate supply chain management systems for aviation enterprises. Here are some of them:

SAP Supply Chain Management: This is one of the leading software products for supply chain management. It provides extensive capabilities for monitoring and managing all aspects of the supply chain, including inventory planning, demand forecasting, production management, and logistics.

Oracle Supply Chain Management: This cloud service offers integrated solutions for supply chain, production, and logistics management. It allows automating many processes of supply chain management and provides advanced analytical capabilities.

Microsoft Dynamics 365 Supply Chain Management: This platform offers integrated solutions for managing all aspects of the supply chain, including inventory planning, order management, production, and data analysis.

IBM Sterling Supply Chain Suite: This software platform provides solutions for automating supply chain, logistics, and production management. It allows optimizing supply chain processes and provides great flexibility in customization to meet specific enterprise needs.

Epicor Supply Chain Management: This system offers integrated solutions for supply chain, production, and logistics management. It allows automating many routine processes and improves the efficiency of supply chain management.

I suggest briefly familiarizing yourself with two of the most popular systems: SAP SCM and Oracle SCM. The inventory management module functions in SAP and Oracle systems cover the following:

In the SAP system:

- Inventory management at warehouses and bases using valuation methods.
- Management of serial numbers and batches.
- Generation of reports on assortment, operations, and inventory valuation.
- Warehouse and accounting management of receipts, issues, and transfers of goods between warehouses.
- Assembly and packaging for shipment.
- Creation and maintenance of multi-level product specifications.
- Manual or automatic material issuance and receipt of finished products.
- Accounting and control of materials based on their quantity.

In the Oracle system:

- Automatic generation of optimal supplier lists.
- Inventory replenishment using methods such as Reorder Point, Two-bin system, minimum-maximum.
- Analysis of inventory groups.
- Batch and serial number management.
- Goods sorting.
- Packaging and repackaging of goods.
- Inventory write-off.
- Handling of surpluses and shortages.
- Inventory counting.

CHAPTER 2
ANALYSIS OF THE CURRENT STATE OF SPARE PARTS SUPPLY MANAGEMENT FOR AVIATION COMPANY

2.1. Overview of modern practices and problems of spare parts supply management

Analysis of the current state of spare parts supply management for aviation enterprises provides insight into the current trends, challenges, and issues faced by companies in this industry. Let's review the modern practices, identify the main challenges and shortcomings of existing systems, and consider the needs and expectations from an automated spare parts supply management system for aviation enterprises.

In the current conditions, aviation enterprises face a number of complex tasks in managing the supply of spare parts. One of the key problems is the difficulty of integrating various elements of the supply chain and the large number of external suppliers. This can lead to delays in deliveries and the inability to timely provide spare parts for aircraft maintenance and other technical systems, which threatens flight safety and the operations of airlines. Additionally, the variety of aircraft models and technical equipment complicates inventory management and can result in either excessive stock or insufficient spare parts.

Managing spare parts supply for aviation enterprises in modern conditions involves a range of complex practices and faces numerous challenges that affect the efficiency and continuity of airline operations. One of the key problems is the complexity of integrating various elements of the supply chain, which involves different suppliers, manufacturers, and distributors. For instance, to ensure proper maintenance of aircraft, airlines must have access to a wide assortment of spare parts produced by different manufacturers.

This can lead to difficulties in coordinating and managing various suppliers, as well as delays in deliveries due to differences in production and delivery timelines. For example, if a particular spare parts manufacturer experiences production or delivery issues, it can result in unforeseen delays in supplies for the airline, potentially impacting maintenance schedules and flight safety.

Additionally, the wide variety of aircraft models and technical equipment complicates inventory management. Each type of aircraft may have its own unique characteristics and spare parts requirements, necessitating a tailored approach to inventory management. For instance, one type of aircraft might require rare or specialized spare parts that are difficult to obtain or expensive.

These issues highlight the necessity for developing and implementing automated supply management systems for aviation enterprises. Such systems can help reduce the complexities of coordinating with suppliers, optimize inventory management, and ensure the continuous supply of necessary spare parts for aircraft maintenance.

Similar problems have been encountered by all major aerospace companies. Boeing, as one of the world's largest manufacturers of aviation equipment, constantly faces significant challenges in managing spare parts supply. For example, during the development and production of the Boeing 787 Dreamliner, which was the first aircraft to use a large amount of composite materials and aimed for economic and environmental efficiency, Boeing faced substantial difficulties in the supply and integration of these materials. To address these issues, Boeing decided to invest in integrated supply management systems that allow for monitoring and controlling all supply chains and ensuring the timely delivery of parts for aircraft production.

Airbus, Boeing's competitor, also has a vast network of suppliers and faces similar challenges in spare parts management. To ensure production efficiency and reduce the risk of delays, Airbus has enhanced its supply management systems. A key strategy has been developing strategic partnerships with reliable suppliers and implementing integrated supply chain management systems that allow for effective coordination and control of the entire supply process.

Russian aircraft manufacturers, such as Tupolev and Ilyushin, also have their unique challenges in supply management. They often face limited access to foreign suppliers and technologies, which can complicate their production. To ensure timely supply and reduce costs, Tupolev and Ilyushin use internal supply management systems that enable detailed inventory tracking, demand forecasting, and efficient interaction with suppliers.Ці приклади демонструють, що в управлінні постачанням запчастин для авіаційних підприємств використовуються різноманітні стратегії та підходи в залежності від специфіки бізнесу та виробничих процесів.

Throughout the development of the aviation industry and with the increasing complexity of technologies, there has arisen a need for improved supply management systems. The modern aviation sector faces several challenges, such as stringent safety standards, growing competition, market globalization, and rapid technological changes. Accordingly, spare parts management systems have become more complex and are designed to address a wide range of tasks. In this context, we will examine an important aspect of strategic supply management. Approaches to this involve developing strategies and plans to optimize supply chains. In the aviation industry, this means selecting the best suppliers to ensure high-quality parts and developing long-term partnerships for stable supply.

The second important aspect is inventory management, which focuses on the effective management of spare parts inventories. For example, when an aircraft requires an engine replacement, inventory optimization will allow for the rapid identification of available stock and the quick implementation of necessary parts to address the issue. The third aspect is supply and logistics management, which is aimed at optimizing the processes of supply and logistics for spare parts. Effective logistics will reduce delivery times and transportation costs.

The fourth aspect is the use of modern technologies and information systems. Implementing inventory management software allows for the automation of ordering and tracking processes. The fifth aspect is risk management strategies. Risk management strategies ensure continuity of supply by involving alternative suppliers or reserves.

This project aims to explore and analyze various approaches and strategies for managing spare parts supply in the aviation industry and to develop recommendations for improving the efficiency and reliability of these systems.

Let's consider a specific example of applying methods and technologies to develop a spare parts management system for an aviation company, using Delta Air Lines as a case study. Delta Air Lines is a U.S. airline headquartered in Atlanta, Georgia, and one of the four founding companies of the SkyTeam passenger airline alliance. As one of the largest airlines in the U.S. and the world, Delta Air Lines faced significant challenges in securing spare parts for its aircraft fleet. The need for a wide variety of spare parts for different types of aircraft led to difficulties in inventory management and maintaining reliable technical operations. To overcome these challenges, Delta decided to develop and implement an automated spare parts management system.

Agile Methodology: The Delta development team used the Agile methodology for the phased development and implementation of the system. Starting from project initiation and requirements definition, they ensured continuous feedback from the client and flexibility in making changes.

Integration with ERP Systems: Delta integrated its supply management system with the existing ERP system, which automated the accounting and processing of orders and optimized financial processes.

Use of Cloud Technologies: To ensure the accessibility and scalability of the system, Delta used cloud technologies for data storage and software deployment.

Utilization of Intelligent Data Analysis: Analyzing large volumes of data allowed Delta to predict the demand for spare parts and optimize their inventory in real time.

Development of Mobile Applications: Delta developed a mobile application for its technical staff, allowing them to order parts and track deliveries from anywhere.

This example illustrates how the application of various development methods and technologies helped Delta Air Lines improve spare parts management and ensure the reliability of the technical operation of its aircraft fleet.

2.2. Identification of the main challenges and shortcomings faced by companies

One of the main challenges of existing spare parts management systems for aviation enterprises is the need for high precision and speed in inventory management to prevent disruptions in production and maintenance. The speed of response to changes in demand and technical requirements can be critical for ensuring uninterrupted operations and high production efficiency. However, some existing systems may not be flexible enough to effectively address these tasks. For instance, some systems may have limited capabilities for demand forecasting and real-time inventory management, leading to strategic gaps in supply and resource utilization.

Additionally, the high costs associated with the development, implementation, and maintenance of modern spare parts management systems can be a significant drawback. Developing and implementing advanced supply management systems may require substantial investments in highly qualified personnel, infrastructure, and technology. Some enterprises may face limited financial resources to implement such systems, especially in a competitive market environment and under economic instability.

Other disadvantages include the complexity of integration with existing systems and processes, the heterogeneity of standards and data requirements across different parts of the supply chain, and the limited scalability and flexibility of current systems. These factors can complicate the implementation and efficient operation of spare parts management systems for aviation enterprises.

One example of the challenges in spare parts supply management in aviation is the situation faced by Lufthansa, one of the largest airlines in the world. Managing the supply of spare parts for aviation enterprises like Lufthansa involves a complex network of suppliers, spare parts warehouses, ordering processes, and production operators. Each aircraft consists of thousands of components, and even the smallest delay in delivery or lack of a spare part can lead to flight delays, high costs, and a negative impact on the company's reputation.

For instance, in the case of Lufthansa, the absence of a critical spare part needed for maintenance might necessitate grounding flights or even canceling several flights, leading to passenger dissatisfaction and financial losses for the airline. Additionally, the time lost in searching for and ordering the necessary part can also cause delays in the flight schedule and increase maintenance costs. In such scenarios, Lufthansa might resort to various risk management strategies, such as maintaining additional stocks of key spare parts or developing contingency plans in case of supply chain disruptions. They may also explore opportunities to optimize inventory management processes and collaborate with reliable suppliers.

In this context, it is also relevant to consider the situation in our country. Ukraine, with its significant potential in aviation due to its historical achievements and developments, faces a number of serious challenges and shortcomings in the spare parts supply system for the aviation industry. These problems affect the efficiency, reliability, and competitiveness of Ukrainian aviation both domestically and internationally.

One of the key issues is the obsolescence of the aviation fleet. A significant portion of Ukraine's aircraft fleet consists of old planes that require frequent repairs and replacement of parts. This complicates the work of enterprises servicing these aircraft, as modern aviation safety standards demand the use of new and tested components. However, due to limited funding, many aviation companies are forced to use parts that are no longer in production or seek them on the secondary market. This increases risks and reduces flight safety.

Another serious problem is the lack of a stable supply and logistics system. Funding and investment issues significantly affect the development of the aviation industry. Many

Ukrainian aviation enterprises face difficulties in attracting investments to modernize their production facilities and improve logistical infrastructure. This leads to a decrease in the quality and efficiency of inventory management, which, in turn, affects the reliability of spare parts supply. The lack of funding also limits opportunities for research and development in the field of new inventory management technologies.

Overall, the challenges and shortcomings in the spare parts supply system for Ukraine's aviation industry are complex and multifaceted. Addressing these issues requires a comprehensive approach, including improving logistics, attracting investments, training personnel, and combating bureaucracy and corruption. Only by overcoming these obstacles can the Ukrainian aviation industry fully realize its potential and achieve high standards of efficiency and safety.

2.3. Needs and expectations from an automated spare parts management system

Aviation enterprises have significant expectations from automated spare parts supply management systems. They need systems that ensure precise and rapid planning and coordination of supplies, optimization of inventories, and increased process automation. Such systems should be flexible and quickly adaptable to changes in demand, technological innovations, and regulatory requirements.

Another crucial need is ensuring a high level of security and reliability. The automated system should have built-in mechanisms for data protection and cyberattack prevention, as well as backup and recovery features to prevent data loss in case of accidents or emergencies.

The needs and expectations from an automated spare parts supply management system for aviation enterprises are critical in ensuring efficiency, reliability, and safety in operational activities. Here's a more detailed overview of these needs and expectations:

Precise and Rapid Planning and Coordination of Supplies: Aviation enterprises require systems that can effectively forecast demand for spare parts, allocate orders among suppliers, and coordinate deliveries according to the aircraft maintenance schedule. Quick response to changes in demand or supply is essential to ensure operational continuity.

Inventory Optimization: The system should help manage inventories to achieve the right balance between inventory costs and readiness for repairs or aircraft maintenance.

This means minimizing excess inventory, which can lead to unnecessary costs, while ensuring the availability of necessary spare parts for timely response to scheduled or unscheduled maintenance.

Flexibility and Adaptability: The system should be flexible and easily adaptable to changes in demand, new technological innovations, or changes in the regulatory environment. This is important for maintaining competitiveness and improving processes over time.

Security and Reliability: Special attention should be given to protecting data and information systems from cyberattacks, as well as to ensuring backup and recovery capabilities to prevent data loss in case of accidents or unforeseen situations. The reliability of the supply management system is critical for ensuring uninterrupted operations and protection from potential threats.

Overall, an automated spare parts supply management system for aviation enterprises should be comprehensive, flexible, and reliable, allowing it to effectively meet the needs of the modern aviation sector and ensure the smooth operation of aircraft and the maintenance of flight safety.

Therefore, the analysis of the current state of spare parts supply management for aviation enterprises indicates the need for the implementation of effective and flexible automated systems that ensure precise planning, inventory optimization, and enhanced security. Such systems can address the existing challenges and shortcomings faced by aviation enterprises and meet their needs and expectations.

CHAPTER 3
SYSTEM DEVELOPMENT

3.1. Development of an automated spare parts supply management system

The development of an automated spare parts management system is a complex and responsible process aimed at creating software and implementing technological solutions to effectively manage the supply chain of spare parts for aviation equipment. The main goal of such a system is to ensure the proper level of availability and delivery of spare parts in a timely and efficient manner to ensure the continuity of aircraft and other aviation equipment operations. The development of such a system includes several key stages (fig. 3.1.):

– Analysis of user needs and requirements: Development begins with a careful study of the needs and requirements of aviation enterprises regarding inventory management and spare parts supply. This includes studying processes, existing problems, functional needs, and automation opportunities.
– System architecture design: Based on requirements analysis, the architecture of the system is determined, including the database, software modules, user interfaces, and other components. It is important to ensure scalability, flexibility, and system security.
– Software development: At this stage, programmers create software that includes various functions such as inventory management, supply planning, spare parts monitoring, reporting, etc.
– Testing and validation: The developed software undergoes thorough testing to verify its correctness, reliability, and security. Validation includes checking the system's compliance with user requirements and security standards.
– Deployment and support: After successful completion of development and testing, the system is deployed at the aviation enterprise. Additionally, support and maintenance of the system are provided, including staff training, bug fixing, and functionality enhancements.

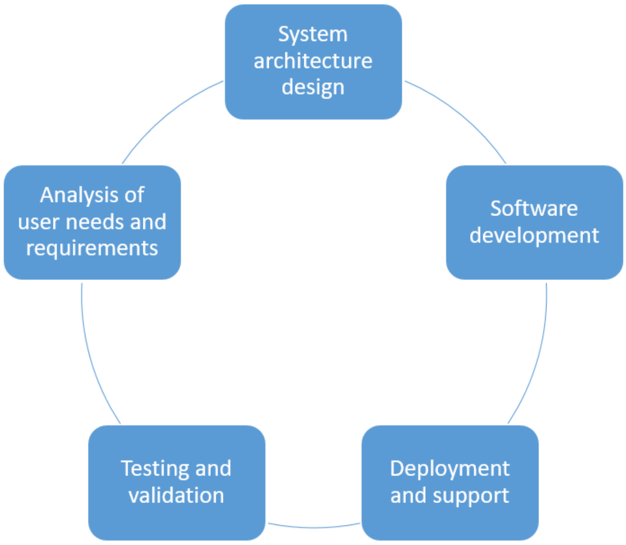
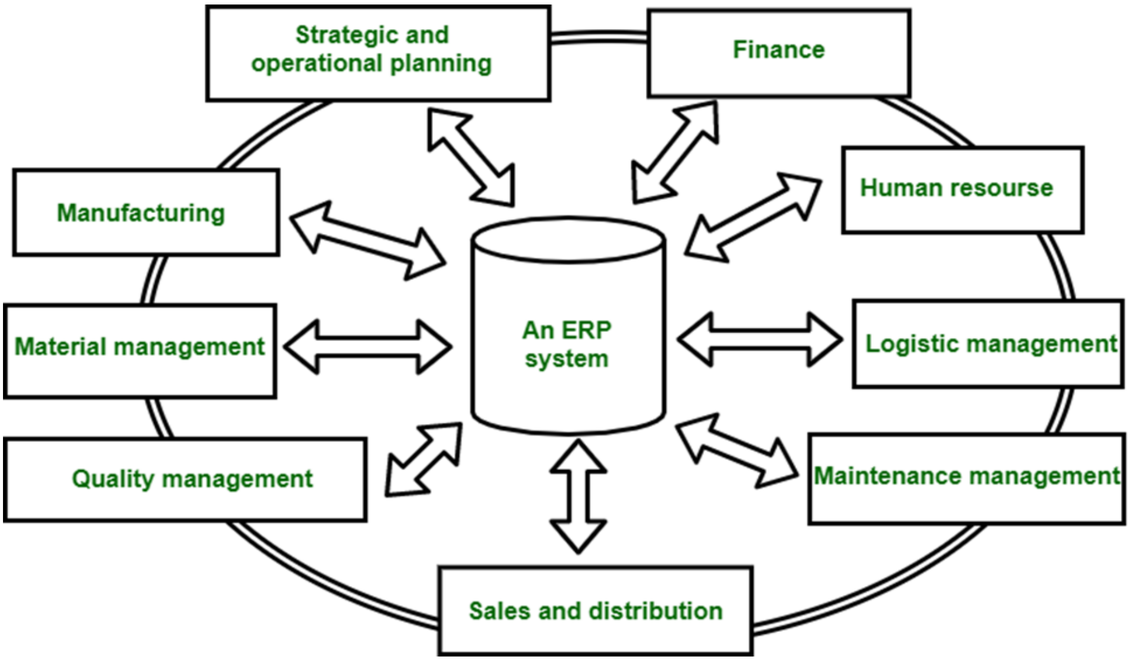


Fig. 3.1. Key stages in the development of an automated control system

3.2. System architecture and functionality

The architecture of an automated spare parts supply management system for aviation enterprises plays a crucial role in ensuring efficient operation and process optimization. Its functional capabilities should meet the needs and requirements of the modern aviation industry. An example of the developed system architecture is shown in



figures 3.2. and 3.3.

Fig. 3.2. Simplified diagram of the developed eps system

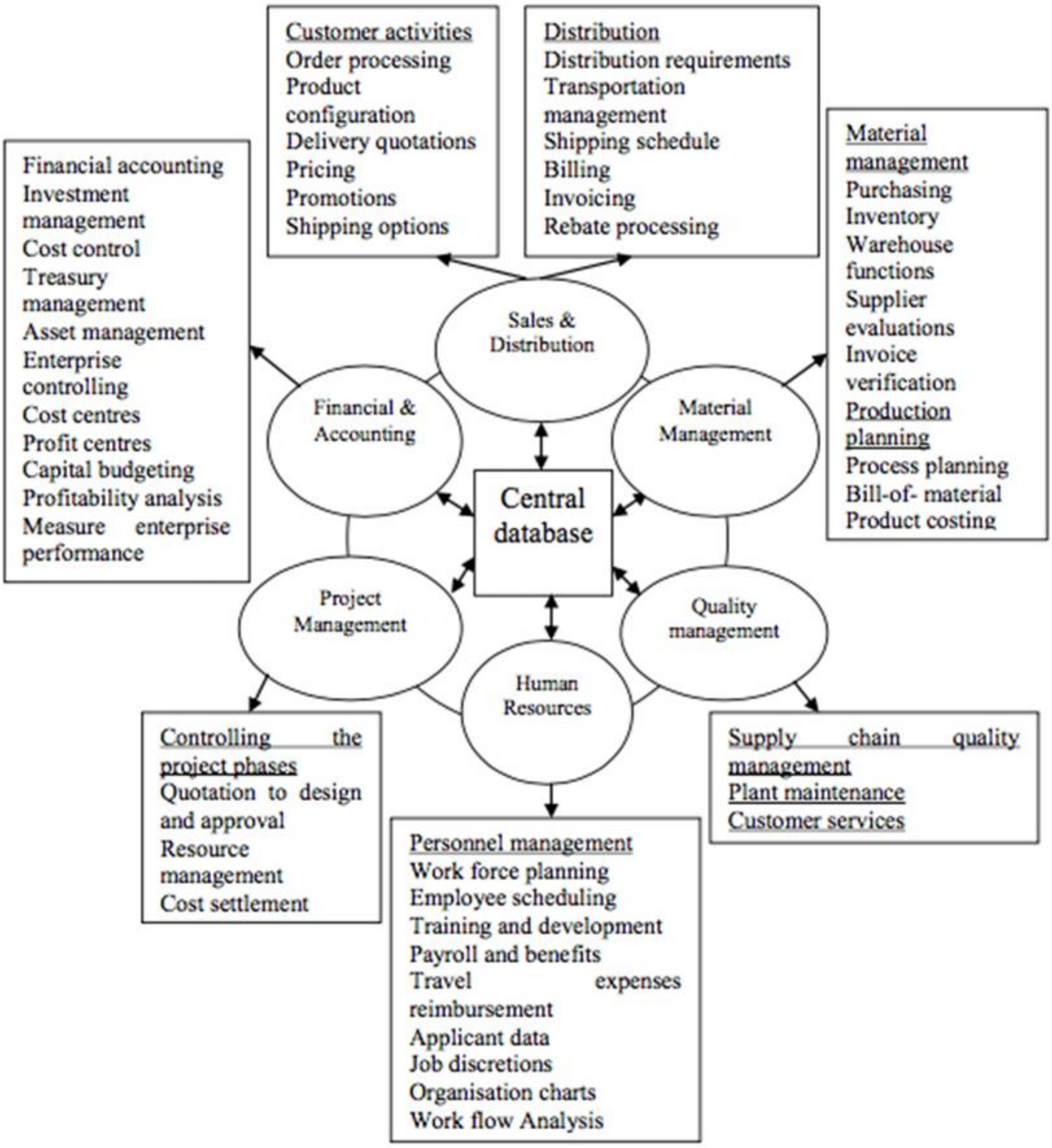


Fig. 3.3. Example of the developed system architecture

First and foremost, the system should have a modular architecture that allows for the integration of various components, such as inventory monitoring systems, supply planning, automated spare parts ordering, warehouse management, and transportation. This will ensure a comprehensive approach to supply management and optimization of the entire supply chain.

To ensure accuracy and efficiency, the system should have built-in analytical tools that allow for demand analysis, cost forecasting, and inventory optimization. This will help avoid excess inventory and ensure timely delivery of necessary spare parts. One of the key functions of the system is ensuring a high level of data security and information protection. This includes the use of modern encryption, authentication, and authorization methods to protect data confidentiality and integrity.

Another important function is integration with modern technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI). Integrating IoT sensors allows for real-time monitoring of spare parts status, enabling prompt responses to changes and avoiding unforeseen problems. The use of artificial intelligence technologies automates decision-making processes, demand forecasting, and supply chain optimization.

Additionally, the system should have an intuitive user interface that simplifies interaction with the system and provides users with the necessary information for effective spare parts supply management. Such a supply management system has the potential to optimize processes and increase the efficiency of aviation enterprises, which is a key factor in their success in the modern competitive environment.

The composition of the stages and works (stages of automated systems development) is shown in Table 3.1.

Table 3.1.

Composition of stages and activities for the system development

Stages	**Work**
Technical design	- Development of design solutions for the system and its parts; - Development of documentation for the system and its parts; - Tasks for detailed design
Working designing	- Development of working documentation for the system and its parts; - Development and adaptation of programs; - Testing of program modules.

Considering the best practices and functional capabilities of leading ERP systems such as SAP and Oracle, I recommend the following plan for creating an effective inventory management system. This approach will help optimize warehouse operations, ensure accurate accounting, and reduce costs:

Development of software for spare parts supply management:

- Selection of a technological stack for development (e.g., Python, Java, C#, MySQL for databases, web frameworks like Flask/Django or Spring).
- Creation of a database to store information about spare parts, suppliers, orders, and inventory status.
- Development of a user interface for convenient data input, inventory monitoring, and order management.
- Implementation of algorithms to automate orders based on demand forecasts and inventory analysis.

Modeling and simulation of the system operation:

- Creation of a supply chain model, including all stages from ordering to receiving and using spare parts.
- Use of simulation software to test the system's operation in different scenarios.
- Analysis of simulation results to determine system efficiency and potential improvement points.

Integration with existing enterprise systems:

- Description of methods for integrating the new system with existing information systems in the enterprise (e.g., ERP, maintenance and repair systems).
- Development of APIs for data exchange between systems.
- Testing integration and resolving potential issues.

Application of artificial intelligence and analytics methods:

- Use of machine learning algorithms to forecast demand for spare parts.
- Development of an analytics system to monitor the effectiveness of supply management, detect trends, and anomalies.
- Implementation of recommendation systems to optimize the spare parts ordering process.

Documentation and user instruction:

– Creation of technical documentation for the developed system, including architecture, database, algorithms, and interfaces description.
– Writing instructions for end-users, including step-by-step guides for performing basic operations in the system.
– Conducting training for personnel who will use the system.

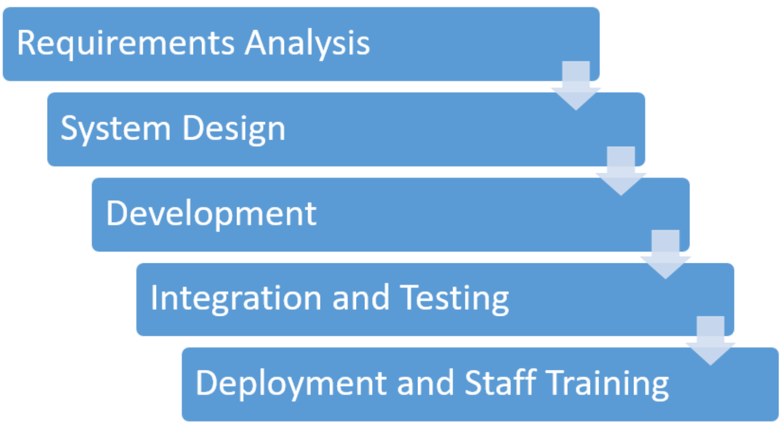
Work plan for the practical part (fig. 3.4.). Requirements analysis: studying current supply management processes at the enterprise, defining requirements for the new system, including functional and non-functional requirements.

System design: developing system architecture, designing the database, creating a user interface prototype.

Development: implementing the database, developing the system backend (server-side), frontend development (user interface).

Integration and testing: integrating the system with existing enterprise systems, conducting testing (unit tests, integration tests, user acceptance tests).

Deployment and staff training: deploying the system at the enterprise, providing training for end-users, offering technical support during deployment. Results analysis and optimization: gathering data on system performance post-deployment, analyzing results



and identifying potential improvements, implementing optimizations based on the obtained data.

Fig. 3.4. Work plan for the practical part

This work plan will help create a comprehensive automated spare parts supply management system for the aviation enterprise, ensuring its efficiency and user-friendliness.

3.3. Requirements for the developed system

The requirements for the inventory management system can be described as follows. The system should provide the ability to calculate optimal inventory levels based on the selected module of the system and the inventory management model of the aviation enterprise. The automated inventory management system should consist of the following modules (fig 3.5.):

– Subsystem for managing spare materials, components, parts, blanks, and assemblies;
– Subsystem for managing materials and components inventory based on schedules;
– Subsystem for order management and warehouse accounting.

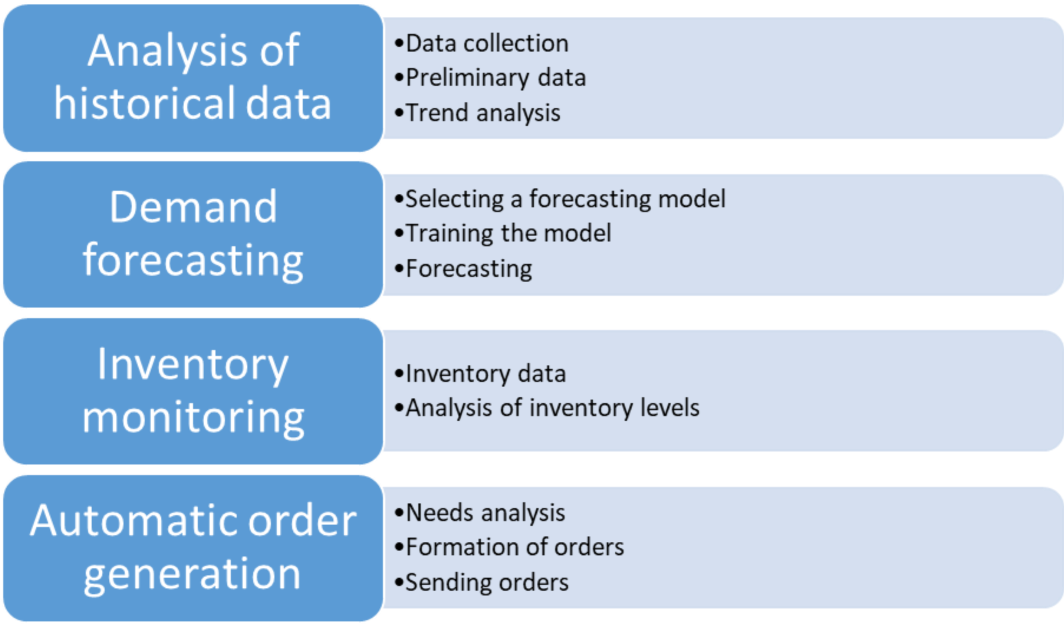


Fig. 3.5. Developed an algorithm for order automation

The system should support report generation. It should facilitate user collaboration and provide them with individual interfaces according to their access rights.

Here are the requirements recommended for the inventory management system:

Requirements for the spare materials and components management subsystem: The inventory management system should be capable of effectively assessing the needs for spare materials and components based on the analysis of data regarding the likelihood of shortages, their costs, and potential penalties for shortages. It should consider not only financial aspects but also the possible consequences of production downtime due to insufficient inventory.

Requirements for the schedule-based inventory management subsystem: The system should provide accurate calculation of required material and component supply volumes based on production schedules. It should optimize the distribution of supply volumes among different suppliers, considering priorities and contractual terms.

Key performance indicators: The system should provide reliable information for strategic inventory management decision-making. This includes reports on production defect rates, calculated spare part requirements, optimal supply volumes, and other important metrics for enterprise management.

Reliability requirements: The system should operate continuously in real-time for all users, regardless of data volume and other factors.

Security requirements: Ensuring the security of the inventory management system should include compliance with personal computer and server security standards used for system operation.

Ergonomics and design requirements: The system should have a user-friendly and visually appealing user interface that simplifies interaction and allows users to perform essential tasks efficiently and quickly.

Operational, maintenance, repair, and component storage requirements: The inventory management system database should be hosted on a server that provides standard data access via a local network or terminal access. Regular database backups should be organized.

Information protection requirements from unauthorized access: The system should guarantee the preservation and confidentiality of entered data. Data access authorization should be implemented at the database level.

The information system should provide:

- Authorized and regulated access for operators (users) to the software and data of the system.
- Recording of user actions in the system when data changes occur.

The system should allow configuration of:

- Access to modules of the "Inventory Management System" and their parts for reading, editing, or approval based on the user's role.
- Visibility of modules of the "Inventory Management System" and their parts based on the user's role.
- Parameters specific to each individual enterprise.

The "Inventory Management System" should ensure user authentication using their identifiers and passwords. Changing user roles or access rights is done by the system administrator.

Requirements for information preservation during emergencies. In the event of failure of one or more workstations, the operation of other users of the "Inventory Management System" should continue. The database server may be part of a fault-tolerant MySQL Server cluster, ensuring continued operation of the database in case of physical failure of one of the servers. In such a case, the "Inventory Management System" should remain functional.

Requirements for protection against external influences. Requirements for protection against external influences for the "Inventory Management System" should meet the requirements for protecting personal computers and servers used to work with this system.

Requirements for the functional capabilities of the system. The functional capabilities of the system can be divided into several blocks. These include general functions that ensure the operation of the entire system, and specialized functions specific to each module of the system. General system functions should provide the ability to:

- Add a new user to the system, including them in an existing or newly created user group.

– Assign permissions for viewing, adding, or modifying each system element for a user group or individual user.
– Create and edit user groups, modify user lists in groups, assign group permissions for viewing, adding, and modifying each system element.
– Add new or modify existing system directories and calculation settings.
– Maintain price lists of suppliers.

Functions of the subsystem for managing spare materials, components, parts, blanks, and assembly units should provide the ability to:

– Add new orders for products.
– Keep track of defect statistics.
– Calculate the required quantity of spare parts.

Functions of the subsystem for managing materials and components based on schedules should allow:

– Calculate material and component needs according to the schedule.
– Generate orders based on calculated requirements and the most suitable volume of deliveries according to supplier price lists.
– Maintain statistics of delays in material and component deliveries by suppliers.

Functions of the subsystem for order management and inventory accounting should provide the ability to:

– Keep track of orders.
– Maintain data on inventory levels of production objects, materials, and components.

Requirements for information provision. Data in the system should be stored in a single database in the form of tables, templates, and other forms of electronic records. Exchange between system components is carried out using one database. All components that transmit information to other components store it in the system's database. Data should be entered using electronic forms. Output information should be presented in the form of reports. In case of power failure or system crash, the system should provide the ability to restore data from a backup.

Requirements for linguistic support. The user interface and all documentation for the system should be developed and supported in Ukrainian, English, German, French, Chinese, Japanese, Spanish, Polish, and Arabic languages.

Requirements for software. The system should operate in the Microsoft Windows 7 operating system or newer, as well as in a version of MacOS that meets the specified characteristics.

3.4. Implementation and operation of the system

Implementation and operation of a spare parts supply management system for an aviation enterprise is a crucial stage that requires careful planning, organization, and coordination of various processes. Below are the steps that can be taken during the implementation and operation of a spare parts supply management system for an aviation enterprise: defining goals and requirements for the system, developing an implementation plan, selecting technologies and system architecture, software development, testing and validation, system deployment, implementation execution, system support, monitoring, and optimization.

Defining the goals and requirements for the system: thoroughly studying the needs of the enterprise and defining the functional and non-functional requirements for the system.

Development of an implementation plan: Establishing a schedule of work, resources, costs, and identifying responsible parties for each stage of implementation.

Selection of technologies and system architecture: Selection of technical solutions and system architecture in accordance with the requirements and needs of the enterprise.

Software development: Creating and debugging the system's software components according to the developed plan.

Testing and validation are two key processes in software development that help ensure the correctness and effectiveness of the system. Testing is the process of verifying the developed program or system against requirements and expectations. During testing, various types of tests are conducted, including functionality, performance, security, and other aspects of the system. The purpose of testing is to identify errors, defects, and shortcomings in the system's operation before its implementation. Validation is the process of verifying whether the developed system meets the needs and expectations of users. During validation, the system's compliance with defined requirements is checked, and whether it meets the needs of the customer. Validation helps ensure that the developed system actually addresses the tasks set and meets the users' needs. Testing includes:

- Functional Testing: During functional testing, the system's compliance with requirements and user expectations is verified. For example, testing may include checking functions such as ordering spare parts, inventory management, and tracking deliveries.
- Integration Testing: Integration testing verifies the interaction between different components of the system and their impact on overall functionality. For example, testing may involve integrating the supply chain management system with other company subsystems, such as accounting or technical support systems.
- Stress and Load Testing: This type of testing allows checking how the system performs under load and in different conditions. For example, speed and efficiency testing of the system may be conducted under conditions of a large number of simultaneous requests.

Validation includes:

- Requirements Compliance Check: An important step in validation is to verify whether the developed system meets the requirements defined during the analysis and design phase. This may include checking functionality, performance, security, and other aspects of the system.
- Testing in Real Conditions: It is important to conduct system testing in real operating conditions to ensure that it works properly in a real environment. For example, a pilot project may be organized to implement the system in a limited area or with a limited amount of data before its full deployment.
- User Satisfaction Evaluation: It is important to assess how satisfied users are with the system. This may include gathering feedback from users, conducting surveys, or observing their use of the system.

Testing is aimed at verifying the quality of the developed product by identifying errors and defects, while validation ensures that the developed product meets the requirements and expectations of users. Both processes are important for ensuring the quality and effectiveness of software. Testing and validation are crucial stages in the development of a supply chain management system for aviation enterprises, helping to ensure the quality and effectiveness of the developed system.

System implementation involves the preparation of necessary documentation, training of personnel, planning of data migration, deployment of the system in the enterprise, and commencement of operations. System support includes providing technical assistance, resolving issues, and updating the system as needed. Monitoring and optimization involve continuous monitoring of the system's status and optimization of its performance to ensure efficiency and productivity is shown in the figure 3.6.

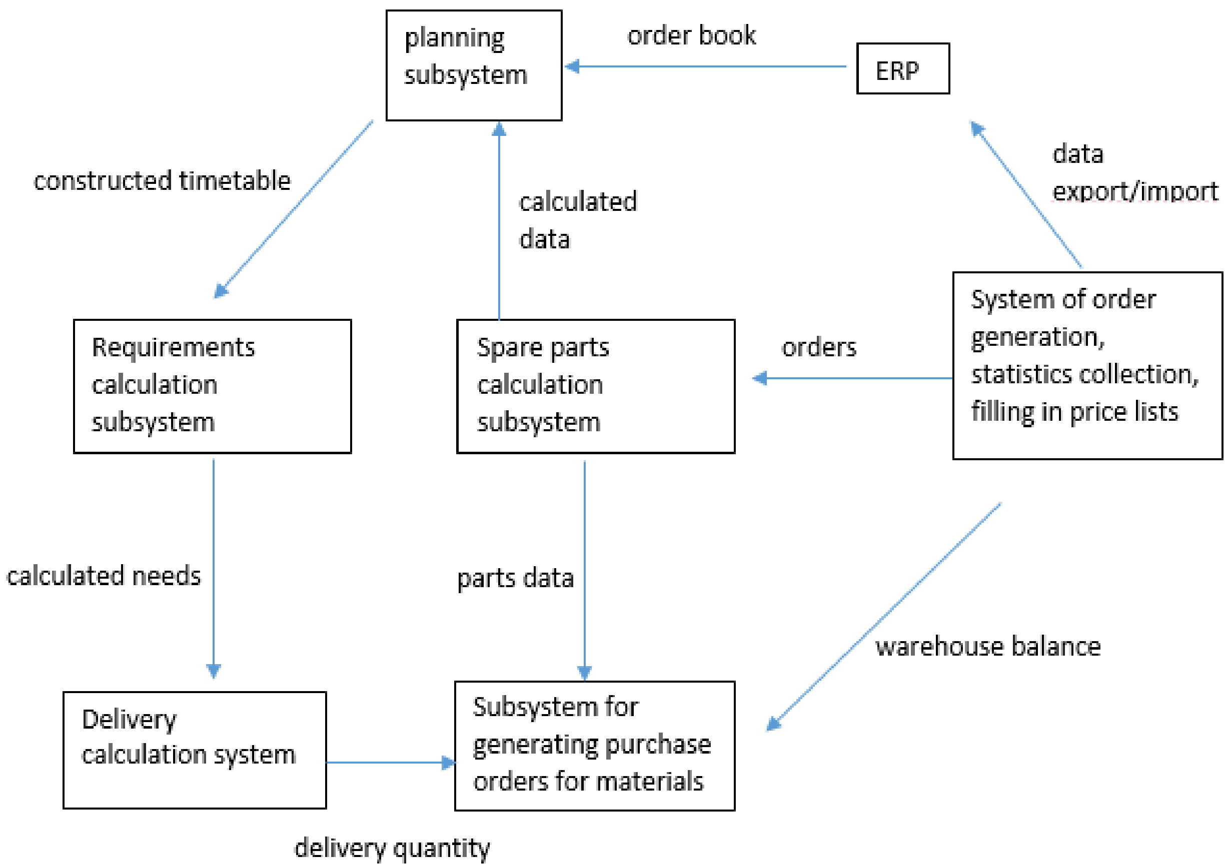


Fig 3.6. Interaction of the inventory management system with other systems

Successful implementation and operation of a supply chain management system for aviation enterprises require careful planning, professional development and testing, as well as effective support after implementation.

3.5. Principle of program presentation

In this section, we will introduce the initial version of our automated parts supply management system, developed using MATLAB. Although this version of the program is still in the development stage, it already demonstrates the core principles underlying its design and provides a basic understanding of its functionality. Our goal is to enable users to visually assess inventory management processes that are typically hidden from view. Using MATLAB allows us to create intuitive graphics that visualize data and make it accessible for analysis even at this early stage.

Principles of program presentation. Data visualization: in the initial version of the program, the main focus is on visually presenting information. MATLAB graphical tools allow for the creation of charts, graphs, and other visual elements that help users quickly and efficiently understand inventory status, demand trends, and other key indicators. Ease of use: although the program is not yet complete, we are already ensuring that its interface is as simple and intuitive as possible. Users can easily navigate between different functions of the program, obtaining the necessary information without unnecessary effort. Flexibility and scalability: even at this initial stage, the program is designed to be easily expandable and adaptable to changes. This allows for the integration of additional features and modules in the future, ensuring the gradual improvement of the system.

Current development status. At this stage, the program includes basic modules responsible for visualizing inventory data. For example, we have developed several charts that display the current inventory levels in warehouses, forecasted needs for the near future, and historical demand with a trend line. These visual tools help users quickly obtain important information and make informed decisions. Below is an example of the MATLAB code used in the program:

```
% Data Initialization
historical_data = [120, 130, 115, 140, 150, 160, 170, 160,
180, 190, 200, 210];
```

```
current_inventory = 500;
reorder_threshold = 150;
days_to_forecast = 30;

% Linear Demand Forecasting Based on Historical Data
x = 1:length(historical_data);
y = historical_data;
coefficients = polyfit(x, y, 1);
forecasted_demand = polyval(coefficients,
length(historical_data) + (1:days_to_forecast));

% Trend Demand Plot
figure;
subplot(2,2,1);
hold on;
plot(x, y, 'b', 'LineWidth', 2);
plot(x, polyval(coefficients, x), 'r--', 'LineWidth', 2);
title('Historical Demand with Trend Line');
xlabel('Month');
ylabel('Number of Parts');
legend('Historical Data', 'Trend Line');
hold off;

% Demand Forecast Plot
subplot(2,2,2);
hold on;
plot(x, y, 'b', 'LineWidth', 2);
plot(length(historical_data) + (1:days_to_forecast),
forecasted_demand, 'r--', 'LineWidth', 2);
title('Parts Demand Forecast');
xlabel('Month');
```

```
ylabel('Number of Parts');
legend('Historical Data', 'Forecasted Demand');
hold off;

% Inventory Level Plot
subplot(2,2,3);
hold on;
bar(1, current_inventory, 'FaceColor', 'b');
plot([0 2], [reorder_threshold reorder_threshold], 'r--',
'LineWidth', 2);
title('Current Inventory Level');
ylabel('Number of Parts');
xticks([]);
legend('Current Inventory', 'Reorder Threshold');
hold off;

% Inventory Status Plot (with Orders)
% Assume orders are added to inventory at the beginning of
each month
current_inventory_data = [500, 480, 450, 470, 460, 440, 430,
420, 410, 390, 370, 350];
months = 1:length(current_inventory_data);

subplot(3, 1, 2);
bar(months, current_inventory_data, 'FaceColor', [0.2, 0.2,
0.5]);
title('Current Inventory Status');
xlabel('Month');
ylabel('Number of Parts');
hold off;
```

```
% Demand Histogram
subplot(2,2,4);
histogram(historical_data, 'FaceColor', 'b');
title('Parts Demand Histogram');
xlabel('Number of Parts');
ylabel('Frequency');

% Order Calculation
total_forecasted_demand = sum(forecasted_demand);
required_order = max(0, total_forecasted_demand -
current_inventory + reorder_threshold);

fprintf('Total forecasted demand for the next %d days:
%d\n', days_to_forecast, total_forecasted_demand);
fprintf('Current inventory: %d\n', current_inventory);
fprintf('Required order: %d\n', required_order);

% Order Automation Logic
if current_inventory < reorder_threshold
    fprintf('An order for %d parts is required.\n',
required_order);
else
    fprintf('Current inventory is sufficient, no order is
needed.\n');
end

% Demand vs Inventory Comparison Plot
figure;
hold on;
bar(1, current_inventory, 'FaceColor', 'b');
bar(2, total_forecasted_demand, 'FaceColor', 'r');
```

```
plot([0 3], [reorder_threshold reorder_threshold], 'k--',
'LineWidth', 2);
title('Demand Forecast vs Current Inventory');
ylabel('Number of Parts');
xticks([1 2]);
xticklabels({'Current Inventory', 'Forecasted Demand'});
legend('Inventory', 'Demand', 'Reorder Threshold');
hold off;
```

Graph "Historical demand with trend line" (Fig. 3.7.). This graph provides a visual representation of historical data on spare parts demand for a certain period of time. It consists of two main elements: historical demand: this is the main part of the graph that shows the actual demand data for spare parts for previous periods. The data can be presented in the form of columns or points that indicate the volume of requests for spare parts in each month, quarter, or other selected interval. Trend line: A line that runs through a graph of historical demand and shows the general trend of changes in demand. The trend line helps to identify general directions (growth or decline) in the demand for spare parts over time. It is a useful tool for identifying seasonal or cyclical changes and for assessing long-term trends.

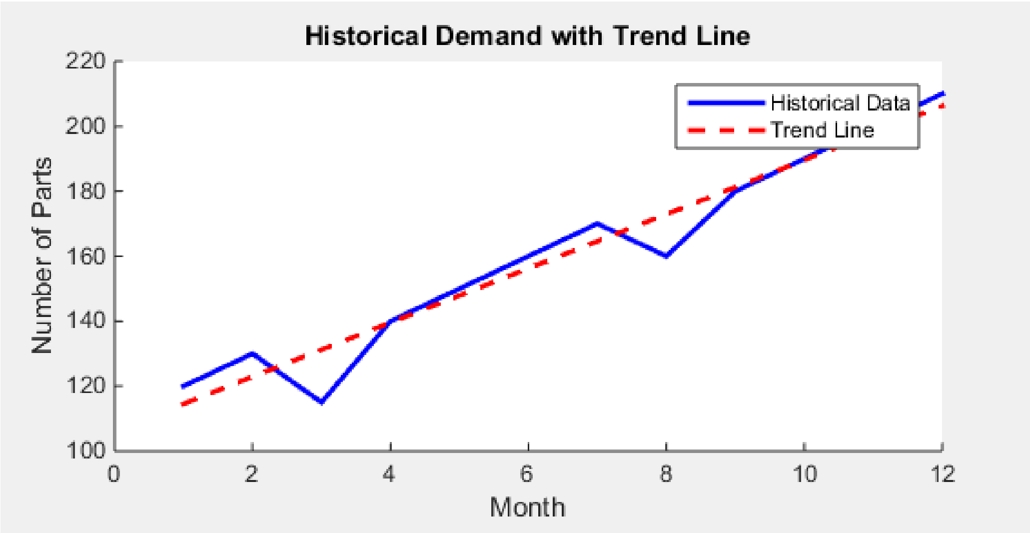


Fig. 3.7. Historical demand with trend line

Graph "Spare parts demand forecasting" (Fig. 3.8.). This graph is used to forecast future demand for spare parts based on historical data and other relevant parameters. It contains the following elements: projected demand. The line or columns on the graph that represent the expected values of demand for spare parts in future periods. This data is based on mathematical forecasting models that take into account historical trends, seasonal fluctuations, current market conditions, and other factors. Uncertainty range: Often, the forecasting schedule includes uncertainty zones that show possible deviations from the forecasted values. This helps to assess risks and plan backup strategies in case of deviations from the forecast.

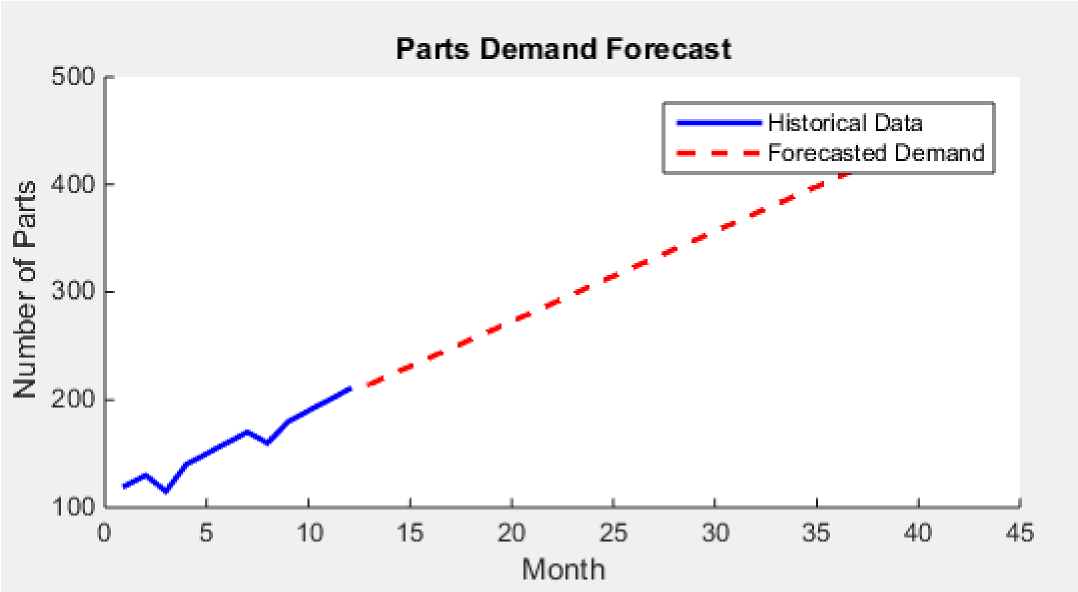


Fig. 3.8. Parts demand forecast

Graph "Current inventory level" (Fig. 3.9.). This graph provides a visual representation of the current state of spare parts stocks in warehouses. It includes the following components. Inventory level: the main part of the graph that shows the amount of each type of spare part currently in stock. This can be presented in the form of columns or lines showing the amount of inventory. Thresholds: Some graphs include threshold lines that indicate minimum and maximum inventory levels. These thresholds help to identify when inventory is approaching critical levels (too low or too high), requiring immediate action to replenish or reduce inventory.

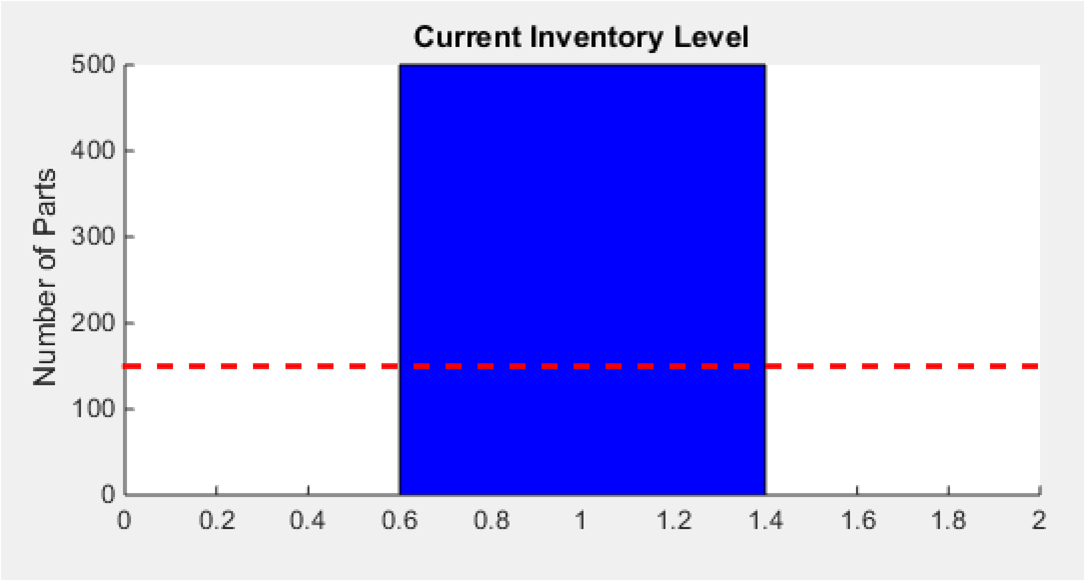


Fig. 3.9. Current inventory level

These graphs are important tools for inventory management because they provide a visual representation of historical data, projected needs, and current inventory status. They allow managers and operators to quickly assess the situation, identify potential problems, and make informed decisions to optimize spare parts management processes. This visual representation of data is an integral part of our automated system, which helps to increase efficiency and reduce the risks associated with inventory management in the aviation industry. Although the current version of the program is only the beginning, it already demonstrates the potential of an automated spare parts management system. The next stages of development will include adding more advanced features, integrating with other enterprise systems, and optimizing the user interface. The full implementation of this system will significantly improve the efficiency of inventory management, reduce costs and ensure the smooth operation of the aviation enterprise.

3.6. Evaluation of the effectiveness and results of implementation

When evaluating the effectiveness and results of implementing a spare parts management system for an aviation enterprise, several key indicators should be considered:

Improved productivity: measured by increased speed and efficiency of order processing, reduced time to complete tasks, and increased overall employee productivity.

Reduced costs: includes reduced inventory costs, optimized inventory management, and reduced maintenance and repair costs.

Improved customer service: measured by improved delivery accuracy and speed, reduced customer wait times for parts, and increased customer satisfaction.

Reduced risk: includes reducing the potential for delays in deliveries, inventory loss, or non-compliance with safety standards.

Increased transparency and control: measured by the ability to obtain detailed information on the status of inventory, orders and deliveries in real time and to effectively control them.

The overall assessment of the effectiveness of a spare parts supply chain implementation system for an aviation enterprise can be positive if it achieves its goals of improving productivity, reducing costs, enhancing customer service, and reducing risks. However, it is also important to systematically monitor and analyze the results to further improve the system.

3.7. Expected contribution of the work to the field of automation

Automating spare parts management processes for aviation companies is an extremely important task that can significantly affect the efficiency and safety of aircraft operations. In today's world, where the accuracy and speed of operations play a critical role, the introduction of automated systems is becoming a necessity. This work is aimed at researching and implementing an automated spare parts supply management system that should improve various aspects of aviation enterprises.

The main goal of implementing such a system is to optimize the processes of receiving, storing, and shipping spare parts, which in turn will increase the overall productivity of the warehouse and reduce inventory costs. Automation will allow for more accurate forecasting of spare parts needs, faster and more accurate order processing, and improved data control and analysis, which will allow for informed decision-making based on real-world performance. Below are hypothetical results of implementing a spare parts supply management system for an aviation company that demonstrate the potential benefits and opportunities that come with process automation. These results can serve as a basis for assessing the effectiveness of the project and its impact on the activities of aviation companies.

Increased warehouse productivity: with an automated system, the warehouse will be able to optimize the processes of receiving, storing, and shipping spare parts. For example, an automated system will allow the warehouse to identify and fix problems in a timely manner, reducing the time it takes to complete tasks.

Reduced inventory costs: implementation of an inventory management system will allow for more accurate forecasting of spare parts needs and reduce unproductive inventory. This will lead to lower inventory costs and improve the liquidity of the enterprise.

Increase the accuracy and speed of order processing: an automated management system will allow you to process spare parts orders more efficiently, reducing the time from order to delivery. This will increase customer satisfaction and improve the company's reputation.

Improved data control and analysis: the system will provide detailed information on inventory status, order fulfillment, and costs in real time. This will allow for more effective process control and informed decision-making based on data analysis.

Increased safety and reliability: reduced order processing time and improved inventory control will help avoid situations where there are not enough spare parts for aircraft repair or maintenance. This will increase the level of safety and reliability in the airspace.

Increased transparency and control: the implementation of the system can increase the availability and quality of information on the status of stocks, orders and deliveries, which will allow for more effective control and informed decision-making.

These hypothetical results demonstrate the potential benefits of implementing a spare parts supply management system for an aviation enterprise. However, the actual results may vary depending on the specific conditions of implementation and the effectiveness of the project.

CHAPTER 4
THE RESEARCH RESULTS

4.1. General assessment of the research results

Given the diverse requirements and needs of aviation enterprises in the field of spare parts supply management, the implementation of an automated management system can have a significant impact on all aspects of the enterprise. Here's a closer look at how the system can improve various aspects of supply chain management:

Improved productivity: an important aspect is to increase the speed and efficiency of order processing. This can be achieved by automating ordering processes, tracking inventory and shipment status, and using analytical tools to forecast demand and optimize inventory.

Cost reduction: the system can help reduce inventory costs by accurately forecasting needs, managing inventory, and avoiding excess inventory. Process optimization will also reduce the cost of equipment maintenance and repair.

Improved customer service: automating the ordering and delivery processes will help reduce customer wait times for parts and increase overall customer satisfaction. Accurate forecasts and quick response to changes in demand will also improve service levels.

Risk mitigation: the system will allow the company to reduce the risks associated with possible delays in deliveries, loss of stock or non-compliance with safety standards. Automatic notification of shortages and the ability to respond quickly will help reduce the impact of such risks.

Increased control: by providing detailed information on the status of stocks, orders and deliveries in real time, the system will allow for effective control and analysis of these processes. This will provide an opportunity to make informed decisions and respond to changes in a timely manner.

Thus, the introduction of a spare parts supply management system can have a significant positive impact on the activities of an aviation enterprise, improving productivity, reducing costs, increasing customer service, and reducing risks.

4.2. Recommendations for the use and improvement of an automated spare parts supply management system

The successful implementation of automated spare parts management systems requires not only technical expertise but also a strategic approach to their development and adaptation to the specific needs of the enterprise. An important part of this process is to analyze the current challenges and shortcomings of existing systems, as well as to develop recommendations for their improvement. In this context, businesses should focus on several key aspects: integrating the latest technologies, improving logistics processes, upgrading staff skills, and ensuring cybersecurity.

Here are some real-world recommendations for addressing the challenges associated with airline parts supply management:

Establish a centralized supply management system: It is recommended to develop a centralized supply management system that integrates all aspects of spare parts supply, including ordering, logistics, warehouse management and analytics. This will allow airlines to maintain greater control over the process and ensure its optimization.

Leveraging advanced technologies: The adoption of advanced supply chain management technologies such as cloud-based solutions, data mining, blockchain, and the Internet of Things (IoT) can help airlines manage inventory more efficiently and forecast spare parts demand.

Developing strategic partnerships: It is recommended to develop strategic partnerships with reliable spare parts suppliers who can provide a steady supply of high quality products. This may include long-term contracts and joint development of new products.

Implementation of Lean and Just-in-Time principles: The application of Lean and Just-in-Time principles can minimize inventory and optimize logistics processes, which allows for more efficient use of resources and lower costs.

Investing in technical innovation: It is recommended to invest in research and development of new technologies that can improve the efficiency of supply management. This could include the use of automated warehouse management systems, the development of autonomous drones for spare parts delivery, or the introduction of data mining to predict demand.

Training and development of staff: It is important to ensure that the staff working in the field of supply management is properly trained and developed. This will help ensure that new technologies and management methods are optimally utilized. An example of the proposed ERP concept is shown in the figure 4.1.

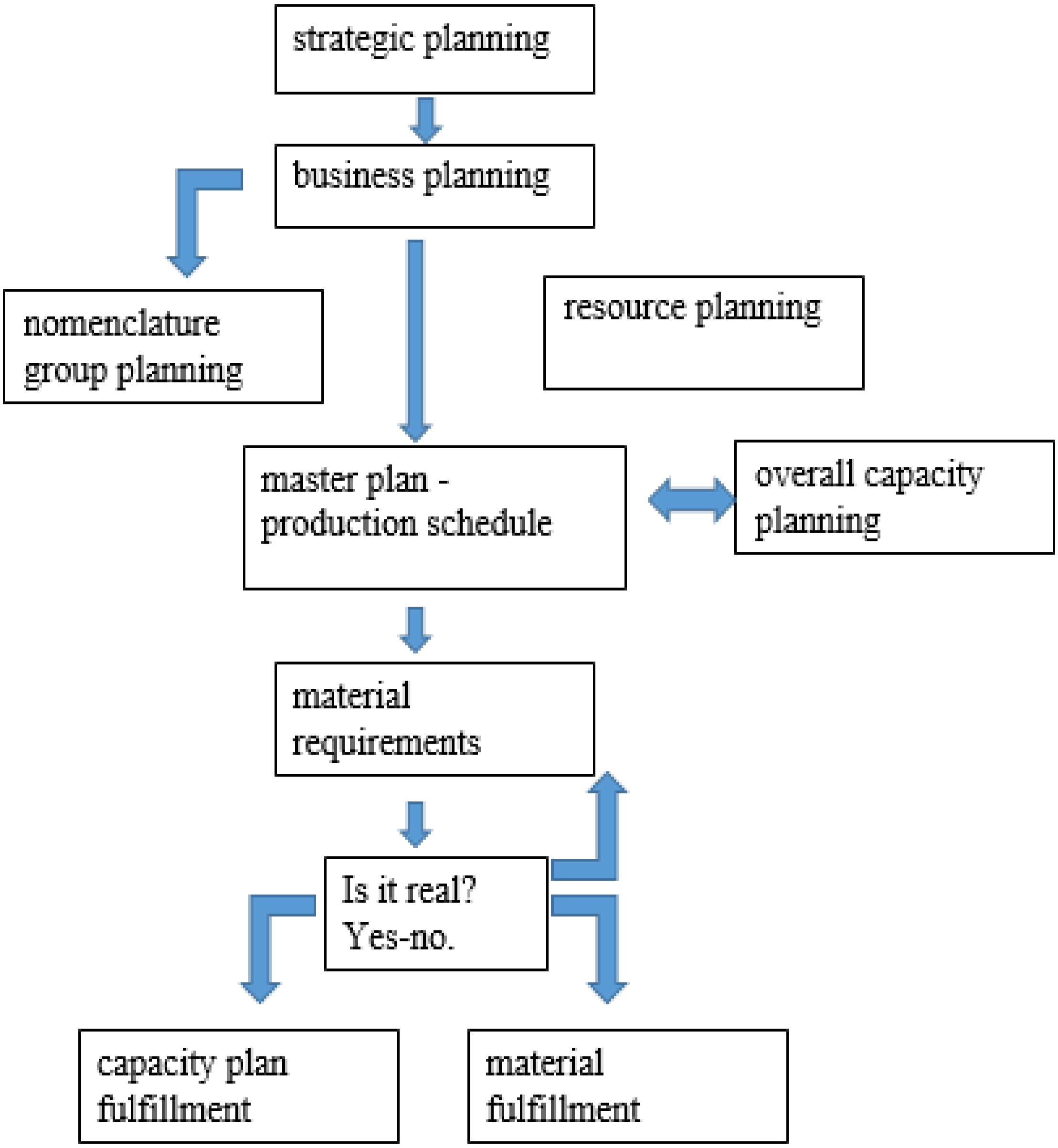


Fig 4.1. Example of the proposed ERP concept

These recommendations can help airlines optimize their spare parts management and ensure the stable and efficient operation of their fleet. In the context of Ukraine, special attention should be paid to financial and infrastructure challenges. Implementing an AMS may require significant investment, which is a challenge in a country with limited financial resources. However, the long-term benefits of implementing such systems, including reduced operating costs, increased efficiency, and improved security, can justify the initial costs.

The disadvantages of existing spare parts management systems, such as lack of flexibility, low integration, and high maintenance costs, can be overcome by a strategic approach to the introduction of new technologies. Aviation companies should focus on developing long-term development plans, taking into account the possibility of adapting to rapidly changing market conditions and technological innovations.

4.3. Impact of the study on the practice of spare parts supply management for aviation company

An automated spare parts management system for an aviation enterprise is an extremely important component in ensuring the continuous and efficient operation of such organizations. The implementation of an automated system has significant potential to improve all aspects of supply management, which in turn can affect the overall efficiency and competitiveness of an aviation enterprise. This study looks at several key aspects that can be improved through automation.

An automated spare parts management system will significantly improve warehouse productivity. Optimization of the processes of receiving, storing, and shipping spare parts will reduce the time required to complete tasks and increase the overall productivity of employees. The system will help to automatically detect and correct problems in a timely manner, which will reduce the risk of delays in deliveries and allow for more efficient use of employees' working time. Integration of the system with supplier databases will automate the processes of ordering and receiving spare parts, which will reduce the time required to complete these tasks. Reducing manual operations in the inventory and supply management process will free up employees' working time to perform more important tasks, such as strategic planning or customer interaction. The ability to analyze inventory and supply data will allow identifying opportunities for cost optimization, such as avoiding excessive inventory and optimizing deliveries. Thus, our research has the potential to significantly improve the efficiency and security of spare parts supply management for aviation companies, which can have a major impact on their operations and competitiveness.

One of the key aspects that can be improved through automation is inventory management. More accurate forecasting of spare parts needs will reduce unproductive inventory, which will lead to lower inventory holding costs. This, in turn, will improve the liquidity of the enterprise, as less funds will be frozen in the form of inventory. In addition, the reduction in equipment maintenance and repair costs will also contribute to the overall cost reduction of the enterprise. Our system will provide aviation companies with tools to analyze the demand for spare parts, which will allow them to more accurately forecast their needs and plan purchases. This will help avoid overstocking or understocking.

The management system will improve the accuracy and speed of order processing, which will reduce the time from order to delivery. This will lead to increased customer satisfaction and improved reputation of the company. Thanks to the ability to respond quickly to customer requests, the company will be able to provide better services and meet customer needs faster, which is especially important in the aviation industry, where speed and accuracy are critical. By automating and optimizing supply chain processes, customers will receive parts faster and more accurately. This will have a positive impact on their perception of service quality and increase their satisfaction. All data on orders and deliveries will be available in real time, allowing the company to respond quickly to customer needs and avoid possible delays in deliveries.

The implementation of the automated system will help reduce the possibility of delays in deliveries and loss of inventory. The system will provide accurate inventory control, which will help to avoid situations when there are not enough spare parts for aircraft repair or maintenance. This will increase the level of safety and reliability in the airspace, as all the necessary parts will be available on time. An automated inventory and supply control system will help to avoid situations where insufficient stocks can lead to interruptions in aircraft operations. This will reduce the risk of accidents and negative impact on flight safety. Ensuring the accuracy and reliability of inventory and supply data will help the company avoid unforeseen situations and optimize management decision-making processes.

The management system provides detailed information on the status of stocks, order fulfillment, and costs in real time. This will allow for more effective process control and informed decision-making based on data analysis. Data transparency and the ability to analyze it in real time will help improve the overall efficiency of supply chain management and reduce the risks of mismanagement of resources.

The introduction of automated supply chain management systems will also allow aviation companies to integrate the latest technologies, such as artificial intelligence and machine learning, to further optimize processes. This will open up new opportunities to improve the accuracy of demand forecasting, optimize supply chain processes, and reduce costs. The use of modern technologies will provide companies with a competitive advantage in the market.

CONCLUSIONS

1. An automated inventory management system for aircraft manufacturing enterprises is designed to automate the process of timely and complete satisfaction of production needs for materials, spare parts, tools, etc. at minimal cost for their delivery and storage based on schedules. In general, an automated spare parts supply management system for aviation enterprises should be comprehensive, flexible and

reliable in order to effectively meet the needs of the modern aviation industry, ensure the smooth operation of aircraft and flight safety.

2. The study identified and analyzed the main aspects of an automated spare parts supply management system for aviation companies. The use of such systems is extremely important for ensuring the smooth functioning of the aviation sector, since the overall productivity and safety of air transportation depends on the efficiency and reliability of spare parts supply.
3. The main purpose of this system is to ensure the proper level of availability and delivery of spare parts in accordance with the needs and requirements of the enterprise, which ensures the efficient operation of the airline. The main functions of an automated spare parts supply management system for an aviation company include: inventory management: track and manage the quantity, location, and movement of spare parts, ordering and procurement: automate the ordering and procurement process for spare parts, including sourcing, price comparison, order placement, and delivery control, logistics and distribution: optimize logistics processes, including planning, receiving, and distributing spare parts, accounting and Reporting: maintain inventory records, supplier information, financial statements, and generate reports on inventory status, costs, and performance.
4. An automated spare parts supply management system for an aviation enterprise has the potential to significantly improve productivity, reduce costs, enhance customer service, reduce risks, and increase transparency and control over processes. Implementing such a system will help aviation companies become more efficient, competitive, and ensure the safe operation of their aircraft. The actual results of the implementation may vary depending on the specific conditions and efficiency of the project, but the potential benefits are obvious. The automated system will allow the warehouse to optimize the processes of receiving, storing and shipping spare parts, which will increase the warehouse's productivity. For example, the system will detect and fix problems in a timely manner, reducing the time required to complete tasks. Implementation of an inventory management system will allow you to more accurately predict the need for spare parts and reduce unproductive inventory. This

will reduce the cost of maintaining inventory and improve the liquidity of the enterprise.

5. An automated management system will allow you to process spare parts orders more efficiently, reducing the time from order to delivery. This will increase customer satisfaction and improve the company's reputation. The system will provide detailed information on the status of inventory, order fulfillment, and costs in real time, which will allow for more effective process control and informed decision-making based on data analysis. Reducing order processing time and improving inventory control will help avoid situations where there are not enough spare parts for aircraft repair or maintenance. This will increase the level of safety and reliability in the airspace. The implementation of the system will also help to increase the availability and quality of information on the status of stocks, orders and deliveries, which will allow for more effective control and informed decision-making.
6. In general, automated spare parts management systems open up new horizons for the aviation industry, ensuring high efficiency, safety, and competitiveness. It is important that companies not only implement the latest technologies, but also constantly improve processes and invest in people development. This is the only way to achieve stable and sustainable development in the face of economic challenges and changes in the modern world. The development of an automated spare parts supply management system is a complex and responsible process aimed at creating software and implementing technical solutions to effectively manage the supply chain of spare parts for aircraft. The main purpose of this system is to ensure timely and efficient procurement and delivery of spare parts of the appropriate level to ensure the continuity of operation of aircraft and other aviation equipment.

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