Issue 18, part 1, 2025

https://doi.org/10.23939/sisn2025.18.130

UDC 004.9:658.5

INFORMATION SYSTEM FOR MANAGING OF THE CAR DEALERSHIP NETWORK

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Information system for managing of the car dealership network. In the modern automotive industry, the development of effective information systems for managing dealership networks aimed at optimizing business processes becomes relevant. This work aims to develop and implement such an information system for automotive companies, allowing for effective management of car sales processes, inventory management, and sales analysis. As part of the research, the current state of the automotive industry was analyzed to identify the main management problems and determine business needs. Based on this analysis, an information system concept was developed, considering the specificity of the automotive business and current industry trends.

The already existing systems were considered. These systems are mainly oriented towards retail trade and do not provide possibilities for analysis, accounting, and other functions. Possible competitors include various Ukrainian products such as Skyservice and Minisoft. Programs such as AutoSoft (Netherlands) and CDK (USA), developed by foreign specialists, were also reviewed.

This work examines different sales analysis algorithms that can be applied in car dealership networks, namely ABC analysis and XYZ analysis.

ABC analysis is particularly useful for car dealership networks in managing car inventories and strategic sales planning. The main areas of application include inventory management, strategic sales planning, and optimization of marketing efforts.

XYZ analysis is a method of classifying elements according to their behavior or characteristics. This method of analysis is used in the following areas of the system: car inventory management, demand forecasting, and marketing optimization.

In addition to the analysis of various economic analysis methods and existing tools for managing the information system, this paper also provides a brief overview of the technologies by which such a system can be implemented. Moreover, using IDEF diagrams and their decomposition, the full architecture of this software was developed.

Keywords - car dealership network, management, sales analysis, inventory management, ABC analysis.

Problem Statement

In the context of the expanding scope of car dealership networks, which are increasingly interested in using information systems to manage their activities, effective service management, encompassing various tasks and functions, becomes extremely important. In particular, managing car dealerships requires solving complex organizational tasks, where information systems play a key role. The purpose of these systems in the production process is to effectively utilize resources to increase profit. An important element is the efficient management of employees, who are the primary resource for the full operation of the system. In enterprises with a significant amount of manual labor, such as car dealership networks, the importance of employees grows even more with the increase in production automation. In this context, the success of product sales in the market is determined by the efficiency of the performance in auxiliary and managerial tasks.

The task of creating information systems for car dealership networks is complicated by each dealership's individuality. Developing a universal solution that meets all requirements necessitates actively implementing modern information technologies. The physical and logical distribution of various resources becomes characteristic of enterprises operating under the car dealership network model, emphasizing the need for an innovative approach in developing information systems in this industry. The further development of technologies presents new challenges and opportunities for car dealership networks. The rapid pace of innovation in the automotive industry requires constantly updating information systems to ensure competitiveness. In particular, developing software that allows car dealership networks to effectively interact with customers, monitor market trends, and quickly adapt to changes becomes a priority.

Moreover, the increasing amount of data generated by car dealership networks necessitates developing and implementing data analysis systems. This will help identify and forecast market trends, enhance the effectiveness of marketing strategies, and optimize inventory management.

Analysis of Recent Studies and Publications

Issues in the car dealership networks

Analyzing internet search statistics, we can conclude that the number of searches for buying a car has been increasing over the past five years (Google analysis 2024).

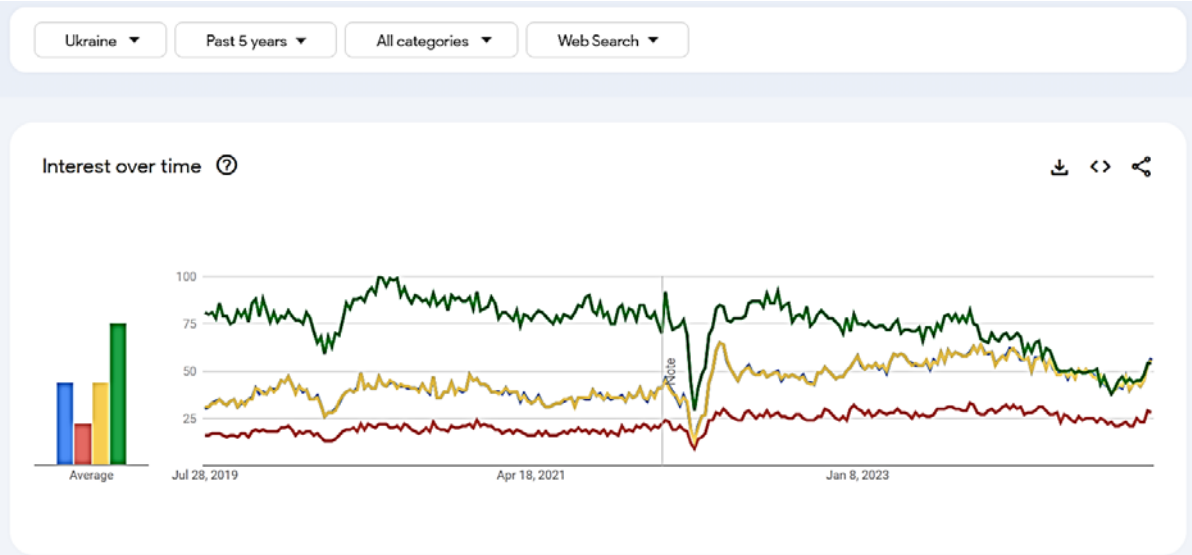

Fig. 1. Analytics of the query 'buy a car'

According to the analysis presented in the Forbes article (Orel I., 2024), the car market in Ukraine shows a positive development trend for the first half of 2023. Sales increased by 50 % compared to the first half of 2022 and are approaching pre-war levels.

Several factors can explain this:

- Recovery from the Covid-19 pandemic
- Increase in household income
- Growth in car purchase financing
- Increased consumer confidence in the market (Orel I., 2024).

The largest growth was observed in the segment of new passenger cars, where demand increased by 85 %. This trend is projected to continue by the end of the year, with the number of new cars sold expected to reach 70,000 units. These figures might even exceed those of previous years.

Sales analysis algorithms: ABC analysis

Let's examine sales analysis algorithms used in car dealership networks and explore their fundamental principles, advantages, and application areas. These tools allow for a deep understanding of sales dynamics, determination of strategic priorities, and effective management of inventory, marketing campaigns, and resources.

ABC analysis is a method of classifying elements (such as products or customers) based on their significance from the perspective of inventory management, strategic planning, and decision-making. This algorithm distributes elements into groups according to their importance, allowing for a focus on strategic aspects of management(ABC-analysis, 2024).

The main concepts of this method include:

1. Classification by Importance: Elements are divided into categories (A, B, C) based on their importance or significance. This allows for prioritizing the most critical or profitable elements for management.
2. The 80/20 Principle: This method is based on Pareto's principle, where a small portion of elements (e.g., 20 %) plays a significant role in overall success or volume of activity (Mazur, O. Y.,2018).

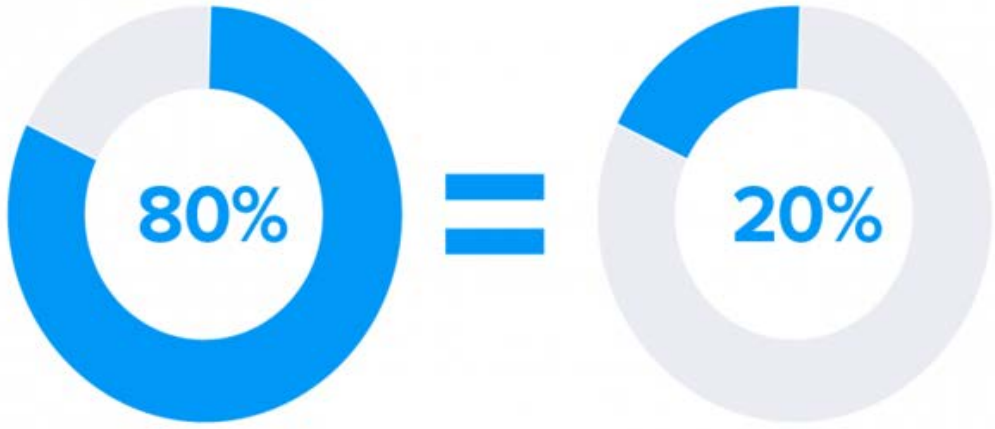

Fig. 2. Pareto Principle

Advantages of ABC Analysis:

Management Priorities: Helps identify the most important elements to focus resources and attention on.

Effective Inventory Management: Optimizes inventory management by concentrating on key and profitable items.

Resource Optimization allows for the rational use of resources by directing them where they are most needed (Ivakhiv Y., 2008).

Application of ABC Analysis in Car Dealership Networks:

- ABC analysis is particularly useful for car dealership networks in managing vehicle inventories and strategic sales planning.

Key areas of application include:

- Inventory Management: Helps determine the optimal inventory levels for key car models, ensuring the availability of the most popular and profitable vehicles.
- Strategic Sales Planning allows the identification of the most profitable models and brands on which to focus marketing efforts and sales activities.
- Optimization of Marketing Efforts: This enables targeting marketing efforts at the most important elements of the product portfolio to maximize effectiveness and profitability (Ivakhiv Y., 2008).

Sales analysis algorithms: XYZ analysis

XYZ analysis is classifying elements based on their behavior or characteristics. It is useful for car dealership networks in inventory planning and optimizing sales strategies (Tyulenieva Y.V., 2017).

The main concepts of this method include:

- Classification by Sales Volume: Elements are divided into categories (X, Y, Z) based on their sales volume or usage frequency. This allows for identifying elements with varying levels of popularity and importance.
- Demand Forecasting: XYZ analysis helps predict trends in demand for different products or services based on their historical sales volumes.

Advantages of XYZ Analysis:

- Forecasting and Planning: Enables understanding and predicting demand for products and services, aiding in inventory planning and marketing strategies.
- Classification by Importance: Helps highlight the most important elements (Class X) for focusing attention and resources.

Application of XYZ Analysis in Car Dealership Networks:

- Car Inventory Management: Allows for classifying car models based on their popularity and sales volume to optimize inventory availability and distribution.
- Demand Forecasting: Helps anticipate changes in demand for different classes of cars, enabling better planning of marketing activities and sales campaigns.
- Marketing Optimization: XYZ analysis assists in determining which car models should be the focus of marketing efforts to maximize efficiency and conversion.

Analysis of Existing Programs for Business Management

There are some software solutions suitable for management, but they are mostly focused on retail and do not provide capabilities for analysis, accounting, and other functions. Potential competitors include various Ukrainian products such as Skyservice and Minisoft. We will also consider software developed outside of Ukraine, such as AutoSoft and CDK. These specialized programs are designed for use in car dealership networks and offer a broader range of functionalities.

- MiniSoft is designed for automating financial accounting and management in retail, catering, and services. It offers a wide range of features, including product and service accounting, cash and non-cash management, a customer loyalty system, and staff activity control. The program has various versions, from single-user to network versions, allowing businesses to choose the optimal solution for their needs. The software also integrates with other systems, making accounting and reporting easier (Software from MiniSoft for Trade, 2024).
- SkyService not only simplifies and accelerates workflows but also offers a full range of tools for effective business management and optimization. The functionality of this program is similar to Minisoft, including store management, sales statistics analysis, inventory accounting, and personnel management (Best dealer management system, 2024).
- CDK is an integrated Dealer Management System (DMS) designed for automotive dealerships. Its primary goal is to provide a comprehensive set of tools for effectively managing various aspects of the dealership business. The system offers a unified interface that simplifies access to crucial information, such as inventory data and actual sales performance. Additionally, CDK helps maintain supplier records, provides real-time reports, and optimizes sales. There is a feature for sending personalized vehicle offers with photos and prices. Like other products, it offers integration with other software programs (CDK, 2024).

– Autosoft is an automated dealership management system to optimize various aspects of automotive dealership operations. The system provides many features to enhance efficiency and productivity, including payroll management, reporting, accounting, and more. One of its key capabilities is real-time data monitoring to track trends and make informed decisions. Autosoft assists in adjusting pricing strategies based on costs. It also offers tools for inventory management, allowing managers to monitor departmental performance and obtain insights into operations. The system streamlines order management, enabling the creation and sending of invoices to customers directly from the platform. Autosoft also integrates with other systems, such as CRM and marketing systems, improving overall functionality and promoting a seamless workflow (AutoSoft for Customers, 2024 & Pankiv Y., 2021).

Sum up of the advantages and disadvantages of the considered programs

Analyzing the four presented programs for business automation in various industries, we can identify their advantages and disadvantages.

– MiniSoft, aimed at financial accounting and management in retail, catering, and services, offers a wide range of features, including a loyalty system and staff activity control. However, its outdated interface and the need for third-party programs for sales analysis could be seen as drawbacks.

– SkyService, which has similar functionality to MiniSoft, including store management and sales statistics analysis, offers an additional feature, 'ABC analysis,' which helps identify the most profitable product categories. Additionally, its user-friendly interface and the ability to integrate with other systems make it appealing for businesses.

– CDK, specifically designed for automotive dealerships, provides a comprehensive set of tools for managing various aspects of the business, including supplier records and real-time reporting. Its feature of sending personalized offers could also be crucial for dealerships.

– Autosoft, also aimed at the automotive business, offers a wide range of features to enhance efficiency, including payroll management and reporting. However, its complex interface and lack of real-time data analysis capability may pose challenges for users.

Formulation of the Article's Objective

The aim of this work is the development and implementation of an information system for managing a car dealership network, focused on optimizing the management of car sales processes, inventory control, and sales analysis. The main goal is to create a platform that simplifies routine operations such as inventory accounting and enables prompt data analysis.

The subject of the study includes specific information technologies, software products, and tools used for managing a car dealership network. This encompasses developed customer relationship management (CRM) systems, sales analysis programs, and inventory management tools.

The scientific novelty of the obtained research results lies in the improvement of car dealership network management. The results achieved during this work represent the following scientific advancements:

- For the first time, a Ukrainian software program for managing a car dealership network has been developed. Previously, only retail software or foreign systems were available.
- Implementation of a flexible sales analysis algorithm. The user can select the most appropriate algorithm for a specific task, without being limited to a single option or having to do it manually.
- The ability to generate reports for a specified period.

The results obtained from the research have significant practical value for car dealership companies seeking to improve their business efficiency and meet customer needs. The developed information system and data analysis methods, when implemented in real conditions, enable enterprises to increase productivity, enhance customer service, and improve competitiveness in the market.

This software provides a full cycle of dealership activity management and analysis, including sales, inventory, order processing, financial management, and reporting.

Tools and Applications Required for the Software

For the program to function properly, the following tools are required:

- Platform with JVM support: The application can be deployed on any platform that suports the Java Virtual Machine (JVM), such as Windows, Linux, or macOS.
- Internet access: The application requires Internet access to perform its functions and to enable user interaction through a web browser that supports JavaScript.

Languages and Libraries

The application was developed using the following programming languages and libraries:

- Java: Used to implement the business logic and server-side components of the application.
- Spring Boot: For building standalone, production-ready applications.
- Spring MVC (Model-View-Controller): To create a web application with a well-structured architecture.
- Spring Security: For providing user authentication and authorization.
- Spring Data JPA: For interacting with the database through the Java Persistence API (JPA).
- Thymeleaf: Used as a templating engine to generate HTML pages.
- JavaScript, HTML, CSS: Used for developing the front-end of the application and enabling user interaction through the web interface.
- Bootstrap: Utilized for responsive web design and ensuring a modern appearance of the web pages.

Main Results

Goal Tree of the developed program

Given the complexity of modern challenges and tasks in business, project management, education, and other areas, developing effective strategies becomes a crucial component of success. To achieve set goals and maximize efficiency, systematic approaches and tools that allow for the analysis, planning, and management of processes are necessary.

The «Goal Tree» is one tool that can provide a structured and systematic approach to achieving goals.

Of course, the primary objective of such a system is the efficient and convenient tracking of goods and sales analysis. All work that has been done and will be done is aimed at achieving this goal−creating a system for the most convenient and effective management of a car dealership network, using modern technologies and the best available system capabilities.

Reporting over a certain period is undeniably important for effectively operating a car dealership network. It allows the business to analyze various aspects and make informed strategic decisions. Monitoring sales volumes and analyzing their trends over a specific period is a key stage.

Inventory management is also crucial. Analyzing sales data helps determine which vehicles sell quickly and which remain in stock, allowing for better order planning and inventory optimization.

Forecasting future sales and business development is based on analyzing past sales, which enables the development of strategies to achieve future goals.

Effective sales analysis is a key element in our system's functioning. Its success is ensured by a complex algorithm that forms the core of our software solution. This algorithm can be considered the soul of the system, as its correct selection determines the system's ability to effectively address the tasks at hand and meet the users' needs.

The IDEF0 (Integration Definition for Function Modeling) notation is widely used in modern business process management. This modeling method allows for the systematization and analysis of functions and relationships within organizational processes.

The primary activity of this system involves conducting sales analysis and maintaining inventory records. This process is central to the system and encompasses various subprocesses that will be detailed during decomposition. The execution of this activity depends on the system user and the system itself.

To initiate the activity, various data inputs are required. This includes authorization data for registered users, information for new user registration, as well as a list of products to be tracked and sales information necessary for analysis.

Upon completion of the activity, the possible outputs are the results of the sales analysis and, if necessary, an updated database. The database is updated in cases where changes are made.

Managing this activity involves considering two types of requirements: business requirements, which pertain to the system's functional capabilities in relation to business processes, and algorithmic requirements, which ensure the correct processing of data and accuracy of sales analysis (Matviyenko O., 2004 & Holovin O., 2022 & Bushuyev S., 2021 & Chernov S., 2021).

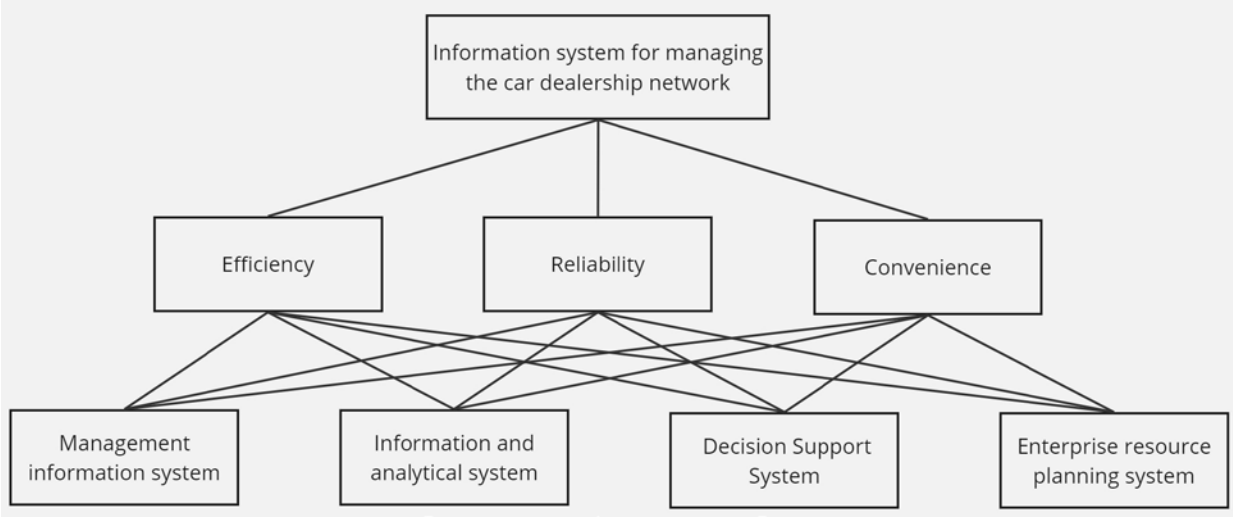

Fig. 3. Goal Tree of the Car Dealership Network Management System.

IDEF diagrams

We will expand the initial model to a deeper level to obtain a more detailed structure. As a result of the decomposition, we identify four main activities: «User Registration», «User Authorization», «Product Management», and «Sales Analysis».

The first process, «User Registration», allows new users to register in the system. Once registered, they gain access to the authorization process and other functions described in subsequent processes.

At the second level, the «Authorization Process» allows a registered user to log in to the system by entering their username and password. After successful authorization, the user can interact with the product management functions. The output of this process is an updated database, which the user can analyze.

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In the third process, «Product Management», operations such as adding products and processing sales are carried out. After these operations, the user can conduct a sales analysis using the system's algorithms. The result of this process is a completed analysis available to the user.

The fourth process, 'Sales Analysis,' involves analyzing sales transactions using prepared algorithms. After conducting the analysis, the user receives a report or analysis results, which can be used for making managerial decisions.

All these processes are governed by business requirements that define the system's functional needs in the context of business processes and the requirements for correct algorithm performance, ensuring the accuracy of data operations and analysis results.

The IDEF0 diagram, expanded to the second level, provides an overview of the core activities that constitute the main function of "Sales Analysis and Inventory Management." However, the activities at the second level of decomposition may not be sufficiently detailed to fully describe the functionality of the system being developed. To address this, we will decompose this diagram further to the third level.

This deeper level of decomposition will offer a more detailed view of the system's processes, allowing for a clearer understanding of the intricate operations involved in sales analysis and inventory management within the car dealership network. This approach ensures that all aspects of the system's functionality are thoroughly captured and articulated.

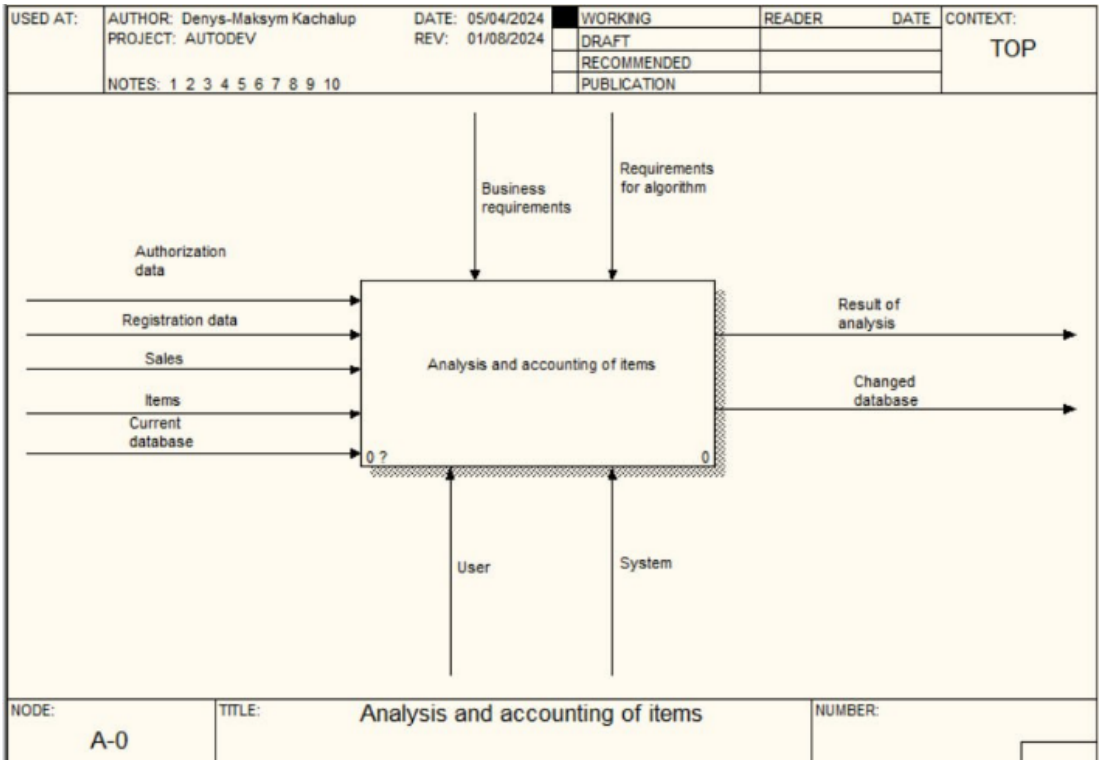

Fig. 4. Initial IDEF0 Diagram for the Car Dealership Network Management System.

Let's start by detailing the activity «User Registration» to the third level. At this level, the following processes will be included:

1. «Checking if a user with the provided data already exists in the database»: This process involves verifying whether a user with the entered data already exists in the database.
2. «Verifying the correctness of the user's data»: If the user is not found in the database, the system allows them to register, and this process checks the accuracy of the entered data.
3. «Encrypting the user's password»: After verification, the user's password is encrypted to be stored securely.
4. «Adding the user to the database»: The final process involves adding the new user to the database after confirming their information.

Each activity takes the user's input data and results in an updated database after completing all the listed processes.

For the «User Authorization» process, a detailed decomposition to the third level can also be carried out to better understand its functionality within the system. Here is a possible description of the process:

1. «Checking if a user with a certain username exists in the database»: This subprocess involves verifying whether the entered user exists in the system's database.
2. «Verifying the entered password»: After identifying the user in the system, the entered password is checked against the stored encrypted password of the user.

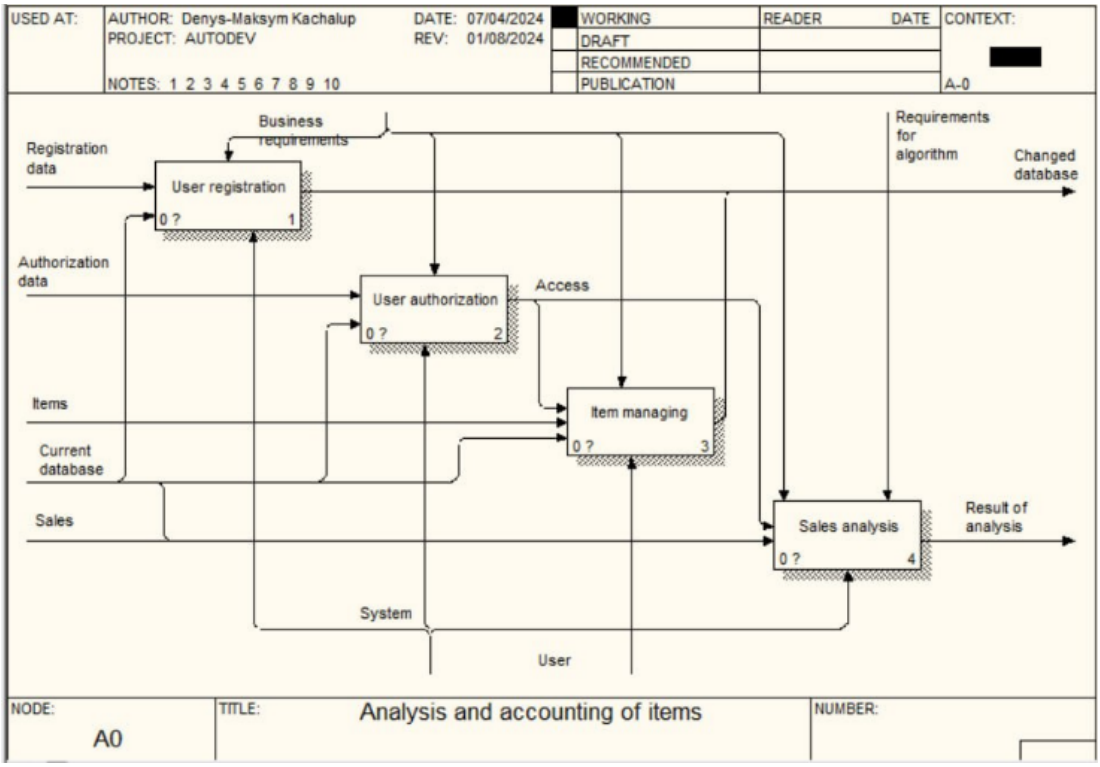

Fig. 5. Decomposition Diagram of the IDEF0 Functional Model of the Car Dealership Network Management System.

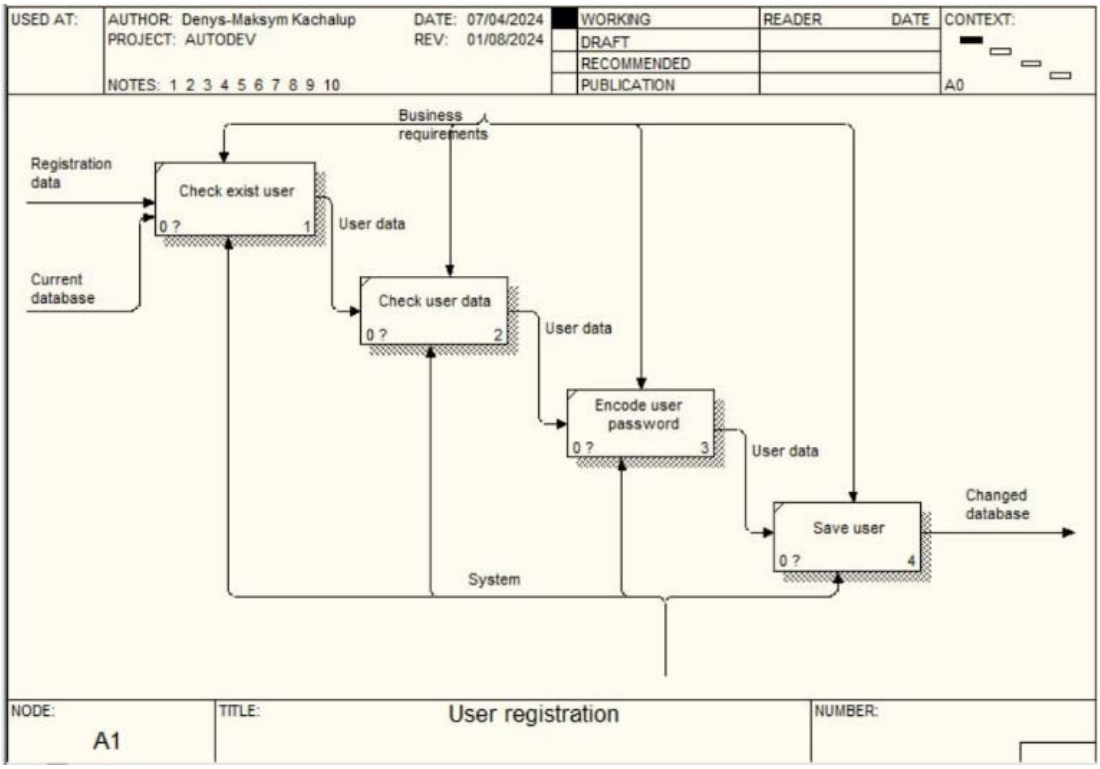

Fig. 6. Decomposition Diagram of the «User Registration» Activity

This subprocess takes authorization data (username, password) as input and produces output results such as granting access or providing an error message. Detailed decomposition helps to reveal all stages of the user authorization process and enhances its understanding within the context of the sales and inventory management system.

The «Product Manipulation» process within the IDEF0 diagram decomposition to the third level includes important subprocesses that enable effective management of products in the system. Let's examine each of these subprocesses better to understand their functionality and impact on the database.

1. «Retrieve Products»: This subprocess involves obtaining information about available products from the input database. It may include searching and retrieving products from storage based on input parameters such as category, quantity, or other characteristics.
2. «Sort Products»: In this subprocess, products are organized or classified according to certain criteria, which may include alphabetical order, categories, price ranges, etc. Sorting helps to arrange data for further analysis and processing.
3. «Delete Products»: This subprocess involves removing specific products from the database. Deletion may occur based on certain conditions, such as product obsolescence or irrelevance.
4. «Add Products»: In this subprocess, new products are added to the database. This may include entering new products or updating existing records with new information.

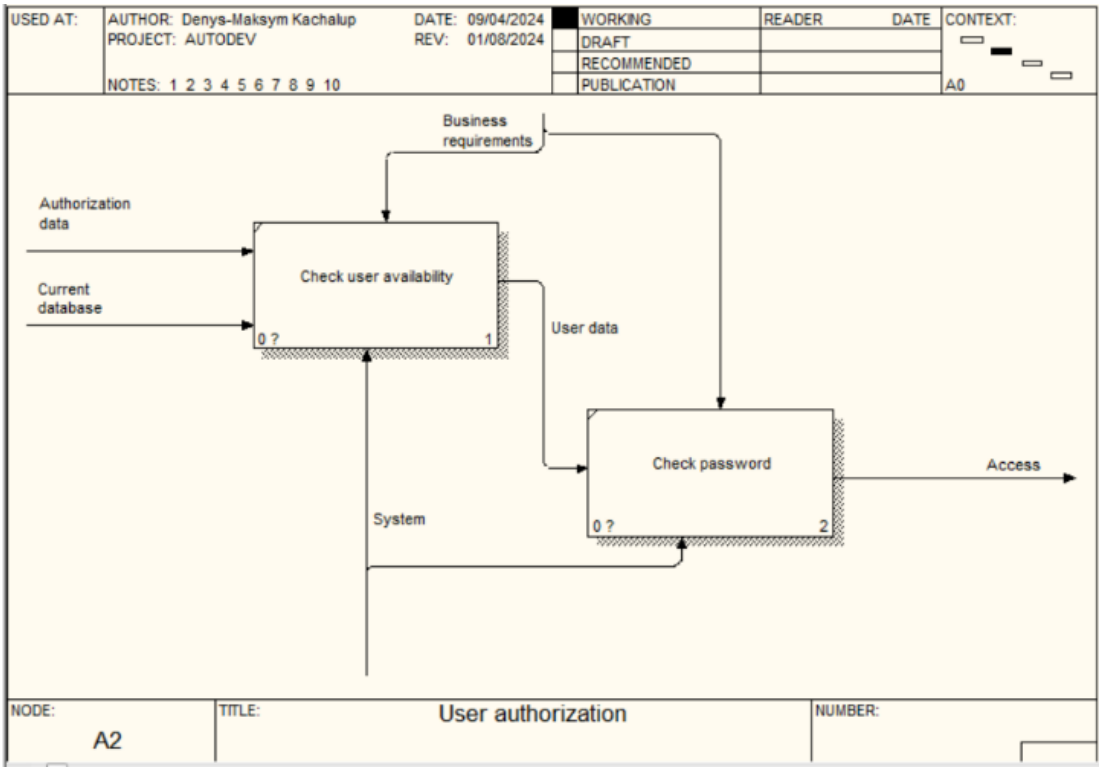

Fig. 7. Decomposition Diagram of the «User Authorization» Activity

Each of these subprocesses receives input data such as access to the database, product information, and the ability to manipulate it according to business requirements. The output of the subprocesses is an updated database reflecting all changes related to product manipulation.

The management of this process is entirely governed by business requirements that define the scope and methods of product manipulation in the system, considering strategic goals and customer needs. This approach ensures effective product management and maintains accurate and up-to-date information in the system's database.

The «Sales Analysis» process within the IDEF0 diagram decomposition to the third level includes critical subprocesses aimed at analyzing sales to obtain information for managerial decision-making. Let's examine the details of these subprocesses:

«Obtain Data for the Report»: This subprocess involves retrieving the necessary sales data from the input database. This data includes information on sales volumes, prices, product categories, etc., needed for conducting the analysis.

«Conduct Analysis According to the Algorithm»: The sales data is analyzed according to a specific algorithm in this subprocess. This analysis includes calculating key performance indicators, identifying sales trends, detecting anomalies, or preparing reports for managerial decision-making.

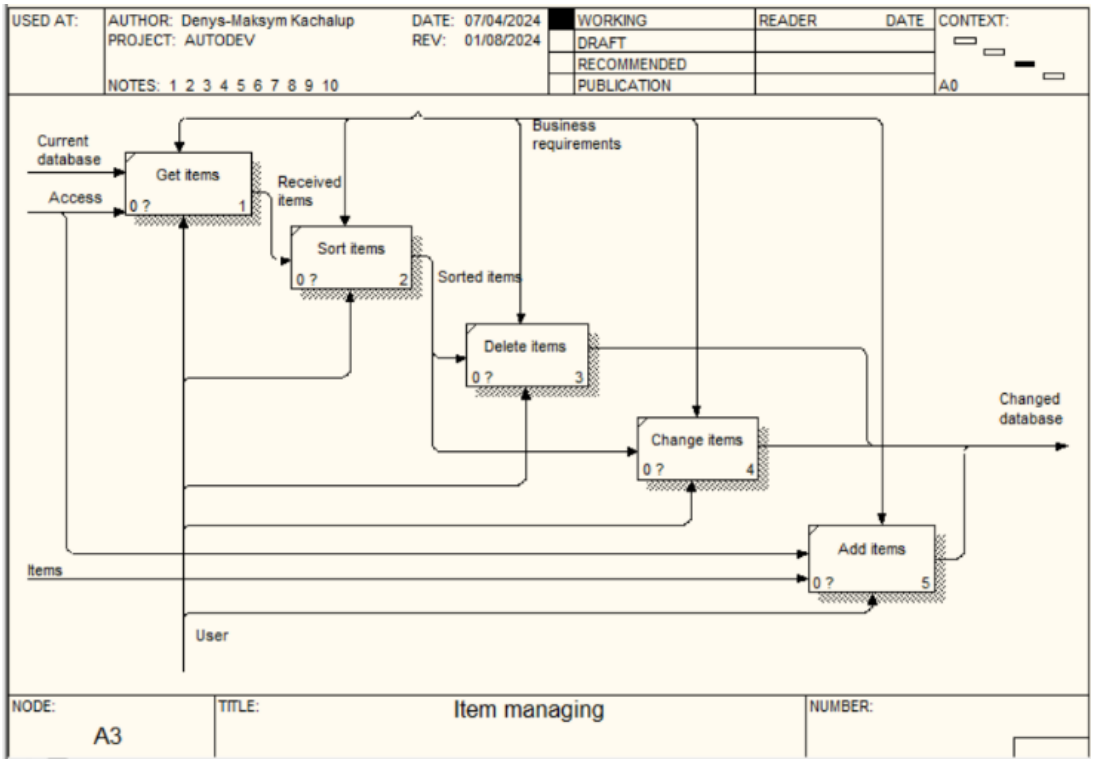

Fig. 8. Decomposition Diagram of the «Item managing» Activity

Each of these subprocesses receives input data from the input database and other necessary parameters, such as access to sales data. The output of the subprocess «Conduct Analysis According to the Algorithm» is the analysis result, which includes summaries of sales analysis, reports, and other information needed for managerial decision-making.

This process is managed in accordance with business requirements and the specifications needed for the algorithm's proper functioning.

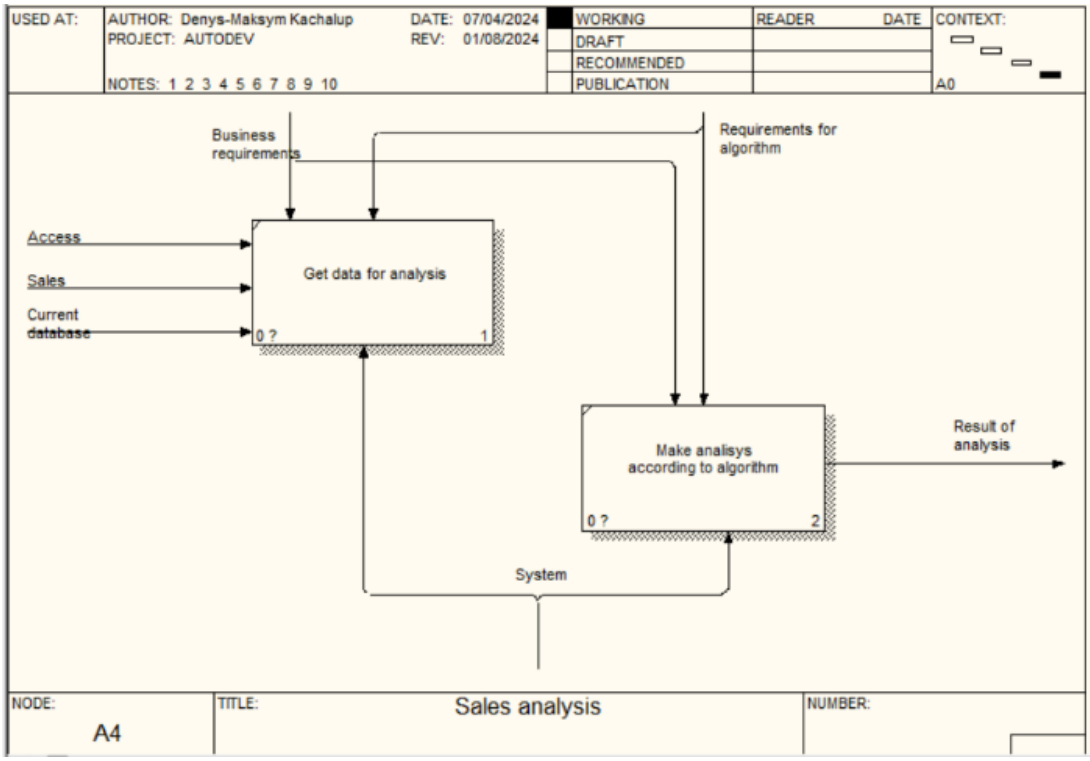

Fig. 9. Decomposition Diagram of the «Sales Analysis» Activity

Conclusions

In this work, an information system for sales analysis and inventory management was developed using data flow diagrams and functional diagrams. The main goal was to create a structured system model that reflects the processes of interaction and data exchange between various components.

First, a functional IDEF0 diagram was developed, which identified the system's main processes, such as user registration and authorization, product manipulation, and sales analysis. In the future, further system development is possible, including implementing the developed models as functional components of the software system and validating them in practice. The next steps in this research are to develop the system mentioned in the article using tools, languages, libraries, and frameworks as already mentioned. After this – we should load the data needed in the system and perform a quality assurance test.

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ІНФОРМАЦІЙНА СИСТЕМА ДЛЯ КЕРУВАННЯ АВТОДИЛЕРСЬКОЮ МЕРЕЖЕЮ

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У сучасній автомобільній індустрії актуальним стає розвиток ефективних інформаційних систем для управління мережами автосалонів, спрямованих на оптимізацію бізнес-процесів. Метою цієї роботи є розробка та впровадження такої інформаційної системи для автомобільних компаній, яка дозволить ефективно керувати процесами продажу автомобілів, управління запасами та аналізу продажів. У рамках дослідження було проаналізовано сучасний стан автомобільної галузі для виявлення основних проблем управління та визначення бізнес-потреб. На основі цього аналізу було розроблено концепцію інформаційної системи з урахуванням специфіки автомобільного бізнесу та актуальних тенденцій галузі. Було розглянуто вже існуючі системи. Ці системи переважно орієнтовані на роздрібну торгівлю і не надають можливості для аналізу, обліку та інших функцій. До можливих конкурентів можна віднести різноманітні українські продукти, такі як Skyservice та Minisoft. Також було розглянуто такі програми, як AutoSoft (Нідерланли) і CDK (США), які є розроблені іноземними спеціалістами.

В цій роботі розглянуто різні алгоритми аналізу продаж, що можуть застосовуватися в автодилерських мережах, а саме ABC-аналіз та XYZ-аналіз.

ABC-аналіз є особливо корисним для автодилерських мереж у керуванні запасами автомобілів та стратегічному плануванні продажів. Основні області застосування включають в себе управління запасами, побудова стратегічного планування продажів та оптимізація маркетингових зусиль.

XYZ-аналіз є методом класифікації елементів за їх поведінкою або характеристиками. Цей метод аналізу використовується в наступних областях системи: управління запасами автомобілів, прогнозування попиту та оптимізація маркетингу.

Окрім аналізу різномантіних економічних методів аналізу та існуючих засобів керування інформаційною системою в цій роботі викладено короткий огляд технологій, за допомогою яких можна реалізувати таку систему. А також за допомогою IDEF діаграм та їхньої декомпозиції розроблено повністю архітектуру даного програмного забезпечення.

Ключові слова - мережа автосалонів, управління, аналіз продажів, управління запасами, ABC-аналіз.