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THE USE OF ARTIFICIAL INTELLIGENCE AND BIG DATA TO PERSONALIZE CAR SALES AND AFTER-SALES SERVICE

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Abstract

This article examines the potential applications of artificial intelligence and big data technologies in the processes of personalizing automotive sales and after-sales service. The relevance of this research stems from the intensifying competition in the automotive market and the need to develop a personalized approach to customers. This paper analyzes the theoretical foundations of artificial intelligence and big data technologies, as well as the specifics of their application in the automotive industry.

Particular attention is paid to the personalization of marketing offers, the analysis of customer behavior, and the use of intelligent algorithms to forecast demand for automobiles. The article examines modern digital tools used by automakers and dealerships to improve the effectiveness of their interactions with consumers. The article also explores the role of big data in organizing after-sales service, including predictive vehicle maintenance, telematics data analysis, and the optimization of service centers.

This article discusses the benefits of implementing smart technologies, including increased sales efficiency, improved customer service, and the optimization of business processes at automotive companies. It also analyzes existing challenges and limitations related to data security, the integration of information systems, and the need to train qualified specialists.

The study's findings show that the use of artificial intelligence and big data is helping to shape a new model of interaction between automakers and consumers, based on in-depth data analysis and a personalized approach to each customer. Looking ahead, the continued development of digital technologies will play a key role in transforming the automotive industry and enhancing its competitiveness.

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Keywords: Artificial intelligence, big data, automotive industry, sales personalization, after-sales service, customer experience, machine learning, data analytics, digital transformation, predictive maintenance, telematics data, automotive market, digital technologies, customer relationship management.

Scientific novelty. The scientific novelty of this study lies in its comprehensive analysis of the application of artificial intelligence and big data technologies to personalize automotive sales and after-sales service processes. The paper systematizes modern approaches to the use of intelligent algorithms for analyzing consumer behavior and generating personalized offers in the automotive industry. Unlike existing studies, this article proposes an integrated analysis of customer interaction processes across all stages of a vehicle's lifecycle, from the selection and purchase of the vehicle through to the service phase. It examines how data analytics can be used to enhance the effectiveness of marketing strategies and improve the quality of the customer experience.

An additional scientific contribution lies in the justification of the role of predictive analytics and telematics data in organizing personalized after-sales service. It has been demonstrated that the use of machine learning algorithms enables the prediction of a vehicle's technical condition and the generation of personalized maintenance recommendations.

In addition, the study identifies the key advantages and limitations of implementing artificial intelligence technologies in the automotive industry, providing a more comprehensive understanding of the prospects for the digital transformation of automotive sales and service processes.

Research Objective. The objective of this study is to analyze the potential and characteristics of applying artificial intelligence and big data technologies to personalize automotive sales and after-sales service processes, as well as to assess their impact on improving the effectiveness of interactions between automotive companies and customers. The study aims to identify mechanisms for using intelligent data analytics to create personalized offers, improve the customer experience, and optimize service processes in the automotive industry.

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Introduction

For more than a century, the development of the automotive industry has been closely linked to the evolution of sales and customer service methods. In the early stages of the automotive market's formation at the beginning of the twentieth century, manufacturers focused primarily on technical improvements to vehicles and scaling up production. One of the most significant milestones was the introduction of the assembly line system for mass production, which made it possible to significantly reduce the cost of automobiles and make them accessible to a broad segment of the population. However, during this period, interaction between the manufacturer and the buyer was minimal. Sales were conducted primarily through dealer networks, and information about customer preferences was virtually never collected or analyzed.

In the second half of the twentieth century, the situation began to change gradually. As competition intensified, automakers began to focus more on marketing strategies and the study of consumer behavior. The first customer relationship management (CRM) systems appeared, allowing companies to record basic information about customers and their interactions with service centers. However, analysis of this data remained limited due to insufficient computing power and a lack of advanced analytical tools.

A true technological breakthrough occurred at the beginning of the 21st century with the development of digital technologies, the spread of the internet, and the accumulation of massive amounts of data. Modern cars have come to be equipped with numerous sensors and electronic systems that generate vast amounts of information about the vehicle's condition and the driver's behavior. Simultaneously, methods of machine learning and artificial intelligence have evolved, capable of processing large amounts of data and identifying complex patterns.

As a result, the automotive industry has entered a new phase of development in which data and intelligent algorithms play a key role. Manufacturers now have the ability to deeply analyze customer preferences, predict their needs, and create personalized offers. The use of artificial intelligence and big data technologies has become an important tool for boosting sales efficiency, improving service quality, and building long-term relationships with consumers.

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Theoretical Foundations of Artificial Intelligence and Big Data. In today's world, the rapid advancement of technology has sparked significant interest in the potential of artificial intelligence. By implementing AI technologies, companies can significantly reduce the costs associated with performing certain tasks, as these tasks can be carried out by machines rather than humans. However, it is important to remember that artificial intelligence is merely a tool for improving processes within organizations. It will not be able to replace humans in the coming years, as it operates on data that is fed into it, and even minor errors in this data can lead to incorrect conclusions [1]. Artificial intelligence is a set of methods and technologies aimed at creating computer systems capable of performing tasks that require human intellectual activity. Such tasks include information analysis, image recognition, forecasting, and data-driven decision-making.

One of the key aspects of artificial intelligence development is machine learning. This method involves the use of algorithms that can independently identify patterns in large volumes of data and create models [2]. In the automotive industry, machine learning is used to analyze customer behavior, optimize pricing strategies, and forecast service needs.

Big data refers to the aggregate of vast amounts of structured and unstructured information that cannot be effectively processed using traditional methods [3]. The main characteristics of big data are volume, the speed at which information is received, and the diversity of sources.

In the automotive industry, sources of big data include data from dealerships, information from online sales platforms, vehicle telematics data, vehicle service history, mobile app data, and the results of customer interactions with the company's digital services.

Therefore, data integration allows for a more comprehensive understanding of the customer. Based on this understanding, it is possible to identify all of their preferences, as well as predict the likelihood that a customer will purchase a particular car model and the terms under which they will use it. Modern data processing technologies are implemented using cloud platforms, distributed computing, and analytical software. Analytical software allows companies to query millions of customer purchase records and identify patterns that would be invisible using traditional method [4].

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Personalizing car sales through data analytics. This strategy is a key concept in the development of the automotive industry. Modern customers expect to be offered terms that most accurately reflect their needs and lifestyle. Due to big data technologies, automakers have access to a vast amount of customer information. Key characteristics include demographic parameters, income level, marital status, product usage history, interests, and mobility profile habits. Marketing offers are developed based on this aggregate data. For example, based on user queries, the system automatically suggests the route best suited to the user. A young family might be offered a more spacious crossover with enhanced safety features, while a city dweller might be offered a compact car with fuel-efficient tires [5].

In addition, personalization is widely used in digital sales channels. Online platforms operated by automotive companies utilize recommendation algorithms that analyze user behavior on the website. The system takes into account the car models viewed, the time spent on pages, the configurations selected by the user, and interactions with advertising materials.

As a result, each customer is shown the most relevant offers. This increases the likelihood of a purchase and shortens the decision-making process.

Another important area is dynamic pricing. Artificial intelligence algorithms analyze market conditions, demand levels, the impact of seasonal factors, and customer behavior. Based on this data, the company creates customized pricing offers and financing programs for each customer. Personalization is also applied when configuring vehicles. Using modern configurators, customers can select the options they need themselves; additionally, the system suggests the most popular and in-demand combinations based on other car buyers' purchases and an analysis of their preferences [6].

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Table 1 - Key Areas of Application for Artificial Intelligence and Big Data in the Automotive Industry

Area of application	Usage characteristics
Personalization of marketing offers	Analyzing customer data enables us to create personalized offers for vehicles, trim levels, and purchase terms that take into account buyers' preferences and needs
Demand forecasting	Machine learning algorithms analyze market trends and customer behavior to forecast demand for various car models
Digital sales channels	Using user behavior analytics on websites and in mobile apps allows us to tailor interfaces and recommendations to each customer
Customer experience management	Intelligent systems analyze customer feedback and inquiries to improve service quality and create personalized interactions
Predictive maintenance	Analysis of telematics data from vehicles makes it possible to predict potential malfunctions and promptly notify owners of the need for maintenance
Optimization of service center operations	Analyzing data on repairs and customer inquiries helps plan service station workload and improve the efficiency of service processes

The table outlines the main areas of application for artificial intelligence and big data technologies in the automotive industry. These areas reflect the key domains of digital transformation in automotive sales and after-sales service processes. The analysis shows that intelligent technologies are used not only to personalize marketing offers but also to forecast demand, manage the customer experience, organize digital sales channels, and improve the efficiency of service operations. The data presented demonstrates that the application of big data analytics enables automotive companies to more accurately address customer needs and improve the quality of customer interactions at all stages of the vehicle lifecycle. A particularly important area is the use of predictive analytics, which enables the forecasting of vehicle technical condition and the optimization of service center operations.

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The Role of Artificial Intelligence in Customer Experience Management.

Customer experience is becoming a key factor in the competitiveness of automotive companies. Artificial intelligence plays a vital role in creating a seamless and effective interaction between the customer and the brand.

One of the most popular tools is intelligent chatbots, which provide round-the-clock customer support. These systems answer questions such as which cars are in stock, what the terms of purchase are, which trim levels are available, and what services are offered [7].

This is achieved using natural language processing technologies, which enable the computer to understand the customer's question and select the appropriate response. Sometimes, such a chatbot can seamlessly transfer the conversation to a live employee at the dealership without the customer noticing.

Another important area is the analysis of customers' emotional responses. This is where artificial intelligence systems come into play. They analyze reviews, social media comments, and survey results. Based on this data, companies can quickly identify areas where their customer service is lacking and take steps to improve the situation.

In addition, intelligent systems make it possible to predict the likelihood of a car purchase. Algorithms analyze a variety of factors, including customer activity on the website, engagement with advertising materials, and the history of interactions with the dealership. As a result, sales managers receive information about the most promising customers and can focus their efforts on working with them.

The Use of Big Data in After-Sales Service. After-sales service is a crucial element in building customer relationships for automotive brands. The latest technologies are closely linked to improving service efficiency and reducing the number of breakdowns caused by technical glitches.

One of the most pressing areas of development in the service business is predictive maintenance. Today's cars are equipped with a multitude of sensors that record the performance metrics of various vehicle systems. This data is collected and transmitted to the automaker's analytical systems.

Machine learning methods are used. They analyze a wide range of data, such as information on the operation of the engine, transmission, braking system, and

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other components. As a result, the algorithms can predict, for example, the likelihood of a future failure of a particular component and notify the car owner well in advance of the need for maintenance.

This not only helps avoid a number of unpleasant situations but also significantly reduces repair costs. The dealer network also benefits, as it becomes easier and more convenient for them to keep their service stations busy.

Personalization also finds application in the development of service offerings. For example, car owners with a specific driving style can be offered specialized maintenance programs. Those who frequently take long road trips may be advised to undergo additional vehicle inspections [8].

Big data is also used to evaluate the effectiveness of service centers. Artificial intelligence takes into account the speed of service completion, customer satisfaction levels, and the frequency of repeat visits to service centers. Based on the data obtained, companies can optimize service processes and improve the quality of the services they provide.

Table 2 presents the key artificial intelligence and big data technologies used in automotive sales and after-sales service processes, as well as the results of their implementation.

Table 2 - The Impact of Artificial Intelligence and Big Data Technologies on the Effectiveness of Automotive Sales and After-Sales Service

Technology	Area of Application	Results of Implementation
Machine Learning	Analysis of consumer behavior and demand forecasting	Improved accuracy of marketing campaigns and increased likelihood of vehicle purchases
Big Data Analytics	Customer segmentation and creation of personalized offers	Increased sales effectiveness and enhanced customer satisfaction
Telematics Systems	Collection of data on a vehicle's technical condition	Ability to identify potential malfunctions in a timely manner
Predictive Analytics	Maintenance planning	Reducing the likelihood of major breakdowns and lowering repair costs
Intelligent Chatbots	Customer support and advice on vehicle operation	Improving access to service information and enhancing the customer experience
Digital Platforms and Mobile Apps	Post-purchase customer engagement	Simplifying service appointments and increasing customer loyalty

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The table presents the main artificial intelligence and big data technologies used in the automotive industry, along with their areas of application and the results of their implementation. This systematic presentation of the data clearly illustrates how modern digital solutions impact automotive sales and after-sales service processes.

An analysis of the information presented shows that the implementation of intelligent technologies contributes to increasing the effectiveness of marketing strategies, improving the quality of customer service, and reducing operating costs. The use of telematics systems and predictive analytics allows companies to identify potential vehicle malfunctions in a timely manner, which significantly increases vehicle reliability and owner satisfaction.

Another important area is the use of digital platforms and intelligent customer support systems, which ensure constant interaction between the manufacturer, dealerships, and vehicle owners.

The Benefits of Implementing Smart Technologies

The use of artificial intelligence and big data analytics in the automotive industry offers a staggering array of benefits. First and foremost, this involves enhancing marketing effectiveness. Personalized offers allow companies to better target their audience and, as a result, increase sales.

Service quality also improves through the use of data. By collecting and analyzing data, companies can quickly respond to customer requests and offer solutions that are as relevant as possible to their specific situations [9].

Positive changes are also taking place in the internal culinary business arena thanks to the implementation of smart technologies. Data automation undoubtedly reduces the workload on employees and requires fewer resources for their training. Instead, employees can focus their efforts on strategic issues.

In addition, predictive analytics reduces the costs of warranty and maintenance services for vehicles. The sooner a potential malfunction is identified, the lower the risk of breakdown for the customer, and thus the higher their satisfaction and trust in the brand.

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Challenges and Limitations of Technology Adoption. Despite significant advantages, the implementation of artificial intelligence and big data technologies comes with a number of challenges and limitations. One of the main challenges is the need to ensure data security. Automotive companies handle large volumes of customers' personal information, so special attention is paid to protecting data from unauthorized access.

Another challenge is the complexity of integrating various information systems. Data can come from a variety of sources, including dealerships, mobile apps, and vehicle telematics systems. Effective analysis requires the creation of a unified information processing infrastructure.

Another important factor is the need for highly qualified specialists. The development and implementation of artificial intelligence systems require the involvement of experts in data analysis, programming, and machine learning.

In addition, there is a risk of over-automating customer interaction processes. Despite the advantages of digital technologies, many consumers still value personal communication with consultants and specialists at dealerships.

Conclusion

Today's automotive dealerships are characterized as competitive and innovative. Competition within the industry is intensifying due to digital technologies, or, in other words, the digital future. Under these conditions, the implementation of artificial intelligence and big data is a strategic priority for enhancing business competitiveness.

An analysis of the digital transformation of the automotive industry has shown that the use of intelligent technologies improves the efficiency of sales and vehicle service processes [10]. Personalized offers based on data analysis allow companies to better meet customer expectations and increase customer loyalty.

Of particular importance is the use of predictive analytics, which makes it possible to anticipate the technical condition of vehicles and prevent potential breakdowns. Consequently, vehicle reliability increases, while maintenance costs decrease.

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The successful implementation of these technologies, however, involves addressing various challenges: ensuring data security, integrating information systems, and training qualified personnel.

In the future, the role of artificial intelligence and big data in the automotive industry will only continue to grow. The development of connected cars, digital platforms, and smart services will create new opportunities for personalizing customer interactions and improving business efficiency.

In other words: artificial intelligence and big data technologies will become a key factor in the automotive industry's new development model, which is focused on individual consumer needs and long-term relationships with them.

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