International Journal of Scientific Engineering and Science
Volume 8, Issue 7, pp. 108-110, 2024. ISSN (Online): 2456-7361

Exploring the Application of Advanced Robotics in Everyday Retail Practice

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Abstract— *This article explores the application of advanced robotics in everyday retail practice, focusing on its potential to improve inventory management, improve customer service and optimize business processes. The current dynamics of the retail robotics market is analyzed, including growth forecasts and key trends such as the integration of artificial intelligence and machine learning into retail operations. Examples of successful use of robotics in large retailers such as Amazon and Walmart demonstrate how robots can significantly reduce operating costs and increase efficiency. Additionally, innovative technologies such as augmented reality and the Internet of Things are considered, which contribute to the creation of a personalized customer experience and support the automation of processes. Thus, the application of robotics in retail represents an important step towards digital transformation and sustainable competitive advantage*.

Keywords— *Robotics, retail sales, sales, modern technologies, opportunities, digitalization*.

I. INTRODUCTION

The fields of robotics and artificial intelligence (AI) are rapidly evolving, dramatically changing the way of life. From everyday household chores to complex industrial operations, robots and AI systems are finding wide applications in various industries. The convergence of robotics and artificial intelligence has led to the creation of intelligent machines capable of sensory interaction, data processing, experiential learning, adaptive responses, and autonomous decision making without human intervention [1].

In turn, the study of the application of advanced robotics in everyday retail practices is a relevant area of research due to the rapid development of technology and its integration into various aspects of commercial activities. In recent years, there has been a significant increase in the use of robots in retailing due to the need to increase the efficiency of operational processes, improve the quality of customer service and reduce costs. However, despite the obvious benefits, the adoption of robotics in the retail industry is accompanied by a number of challenges, such as the high cost of initial investment, technical difficulties of integration, and cybersecurity issues.

II. LITERATURE REVIEW

Edgar, Dunn & Company experts emphasize that retailers should pay more attention to building the overall customer experience. Today's consumers evaluate not only the product itself, but also the entire buying process. Customer experience has become an integral part of the product. The global pandemic has forced many conventional stores to close in 2020, forcing retailers to rethink customer interactions in the face of the new reality.

The retail industry is already actively adopting innovative technologies such as robots, especially in the Far East, where Japan is a world leader in robotics due to its advanced research and development. Robots in retail can collect data about products on shelves and shopping patterns, improving inventory management. Here we are not talking about warehouse robots or robots in fulfillment centers, but robots interacting with customers in the store.

The scope of this article will focus on the opportunities that robotics has in everyday retail practice.

III. MATERIALS & METHODS

The retail robotics market is estimated to be valued at $7.60 billion in 2020 and is expected to exceed $69 billion by 2028, exhibiting a compound annual growth rate of 31.61% from 2021 to 2028. In retail industry, robots are commonly used for inventory management, delivery, and back-end management. This segment is projected to grow at the highest rate of 37.06% from 2021 to 2028.

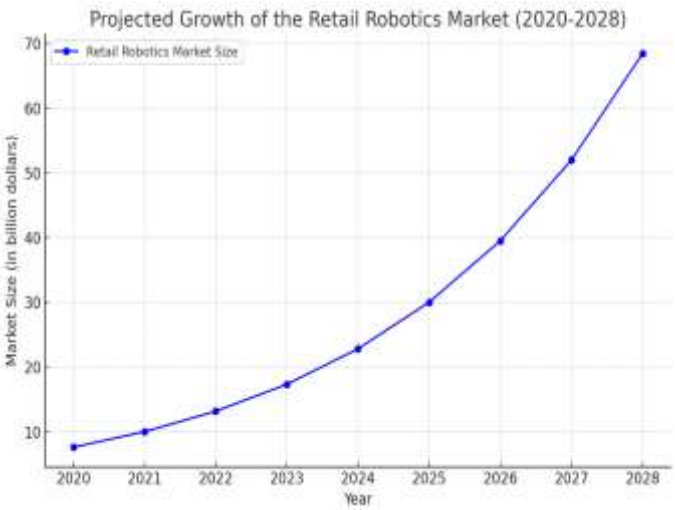

Figure 1. Development of the retail robotics market.

Retail robots equipped with artificial intelligence technologies such as computer vision and machine learning will free store employees from routine tasks and improve informed decision making. This is achieved through the robots' ability to collect detailed product data, identify customer preferences and offer analytics to improve customer experience and increase

revenue. These intelligent systems are capable of collecting accurate data on customer habits and preferences, enabling retailers to recommend suitable products, optimize the checkout process, and improve inventory management.

With increasing consumer demand, retailers are actively adopting robotic automation. Robots help in improving customer interactions by providing personalized experiences and increasing customer satisfaction. The use of robotics in retail improves operational efficiency, drives business growth, and enables retailers to collect, process, and analyze data to make informed decisions and create robust business intelligence. This provides cost efficiency, automation, sustainability and competitive advantage.

The impact of robotics on modern society is multifaceted due to the integration of digital technologies such as cloud computing and data analytics. The Boston Consulting Group (BCG) predicts that the global robotics market will reach USD 87 billion by 2025, with a significant portion of this investment in the retail sector. This is not surprising, given that retail has always been one of the leaders in the adoption of advanced technologies.

Automation has long been an integral part of the retail industry, initially aimed at improving supply chain efficiency. However, current innovations in warehouse and factory automation are taking place under the pressure of stiff competition from e-retailers actively investing in robotics. At Tesco, for example, radio frequency identification (RFID) robots are capable of scanning the inventory of entire stores in one hour, which is significantly faster and more accurate compared to seven hours by a human employee.

Robotics has already transformed the way distribution centers (DCs) operate, dramatically improving the speed and accuracy of order picking. Amazon, for example, has claimed a 20 percent reduction in operating costs through the use of robots. C&S Wholesale Grocery uses robots in its warehouses to pick orders, and Walmart uses drones to monitor stock-outs and accurately allocate products to items.

A new generation of robotics and automated tools can support logistics processes with minimal defects and reach new heights of productivity. For example, Effi-BOT, a fully automated cart used by DHL Supply Solutions, creates a more efficient process for tracking inventory movements and does the manual work of pickers in the warehouse.

The use of robots in logistics and supply chain enables retailers to significantly reduce losses and errors, and effectively reallocate staff to tasks that increase sales. Although drones are currently used to deliver small parcels, in the future they will be able to carry larger and more diverse items in shape and size. This could be a solution to the shortage of delivery drivers, many of whom are approaching retirement age in the US.

Robots could also be useful for small and medium-sized businesses as their costs become increasingly affordable. For example, the Baxter robot, costing about $25,000, has successfully sorted plastic products for over 2,000 hours, demonstrating the high efficiency and return on such an investment for businesses [2].

1. Options for utilizing robots in retailing

Planning and improving retail strategy. Artificial intelligence technologies enable retailers to collect, process and standardize data, automatically input it into existing software or spreadsheets and transform it into easy-to-understand visual elements such as charts and graphs. This helps build effective business plans, reduce reporting time, forecast sales, build accurate customer profiles and understand customer buying preferences.

Improved retail inventory management. Robots moving around stores are now collecting data on shelf availability, providing better insights into customer preferences and actions. Continuous shelf scanning helps avoid stock-outs, resulting in significant cost savings. Retailers can significantly improve their revenues by avoiding inventory deviations, which could result in an estimated $1 trillion in global savings. Customers also become more loyal and satisfied if the right products are always available [3].

Augmented Reality (AR): AR allows customers to "try on" products and view them in their homes using their smartphones. Augmented reality technologies are becoming increasingly popular to help improve the customer experience.

Big Data: Retail stores have always collected data about their customers, but analyzing and using that data has been difficult. Predictive analytics allows businesses to predict the future based on past data, improving the understanding of customer behavior.

Recommender systems: These systems analyze customer behavior and recommend products to customers that they may not be aware of. This helps in increasing impulse purchases and increases overall customer satisfaction.

Internet of Things (IoT): The IoT, which futurists predicted long ago, has become a reality. Many companies are using it to improve supply chain efficiency and increase profits. Experts believe that IoT will radically change the shopping experience.

Contactless order picking. Robots make the click and collect process fully automated. Polish company Retail Robotics has developed the Arctan robot for grocery retailers, while Estonian company Cleveron offers a robotic solution with two temperature zones for storing products. Such solutions are already in use at Walmart, which has more than 1,600 "pickup towers". Zara is also implementing robotic technology for automated order picking, which reduces operating costs.

Self-driving shopping carts. LG and US-based Caper have developed smart shopping carts that check prices and display a shopping list. These carts, used in the Sobeys network, allow shoppers to avoid queues at the checkout and provide an engaging way to shop [4]. Next, Table 1 describes the benefits of digital transformation in retail with the use of robots.

Table 2 will describe examples of the use of robots.

Practical part

1. Operational efficiency and cost reduction:

Amazon uses more than 100,000 warehouse robots in its warehouses. Using robots has allowed Amazon to reduce the operating costs of each of its warehouses by 20 percent or $22 million and increase capacity by up to 50 percent. After all, an intelligent goods transportation system does not require the extra free space that would be needed for humans to walk up to the shelves [7].

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TABLE 1. Advantages of digital transformation for retail business

Advantages	Description
Security	The pandemic has shown that governments can isolate only the necessary workers in the country, leaving many at home. Online stores mitigate such issues, allowing a large portion of the staff to work remotely.
Improved communication with clients	Digitization and social networks have allowed retailers to interact with clients through targeted advertising, websites, chatbots, and much more, making marketing more effective.
Automation of daily tasks	Modern technologies allow the automation of routine tasks, freeing up time for strategic planning and exploring new opportunities for increasing profits.
Revenue increase	The internet enables businesses to reach national and even international levels, capturing various audiences and creating multiple revenue streams.
Improved customer service quality	Digital tools allow companies to analyze client and employee behaviors, creating quality impressions from purchases and increasing the likelihood of repeat purchases.

TABLE 2. Examples of the use of robotics

Robot Name	Description
LoweBot	A robot used in Lowe's stores to assist customers in finding products and answering questions. It also tracks inventory and collects purchase data.
Tally by Simbe Robotics	A robot used in Target stores for monitoring inventory levels and pricing of products. Its goal is to maintain optimal inventory levels.
Pepper by Softbank	A robot used in Softbank stores for interacting with customers, providing information, and enhancing store attractiveness.

2. Self-driving shopping carts:

"Caper.ai smart shopping cart aims to simplify the supermarket shopping experience. The startup has equipped the cart with cameras that can recognize products and scan them. Special sensors detect when products get into the cart, and scales save shoppers from having to weigh their purchases at the checkout.

The cart works like a cash register: after scanning the goods, it includes them in the final receipt. The touch screen shows what goods are included in the receipt, and the built-in terminal allows you to pay by card or with the help of Apple Pay and Android Pay payment systems [8].

LG has also developed a smart cart, the main purpose of which is to exclude the worst part of the shopping process, namely waiting in queues. "Smart" cart independently follows the owner, avoiding obstacles, and help navigate in the supermarket, telling where the goods are. A search request can be sent both through the built-in display and using a special mobile application [9].

3. Revenue growth and market expansion:

The use of robotics in retail is associated with significant revenue growth. The retail robotics market is expected to grow from $7 billion to $55 billion by 2028, reflecting a compound annual growth rate (CAGR) of 28.96% from 2019 to 2026. In turn, you must use the following formula to calculate revenue growth.

$$CAGR = \left(\frac{End\ Value}{Start\ Value}\right)^{\frac{1}{Number\ of\ years}} - 1$$

That is, the CAGR is equal to 0.2896 or 29% in this case.

That is, you can see how much impact robotics has on cost reduction, efficiency and revenue growth in the retail industry.

IV. Conclusion

An examination of the application of advanced robotics in the retail industry has revealed significant potential to improve operational efficiency and customer interactions. Analysis has shown that robots integrated with artificial intelligence technologies can not only free employees from routine tasks, but also provide valuable analytics to inform business decisions. Examples of successful robotics implementations at companies such as Amazon and Walmart confirm the ability to significantly reduce operating costs and improve inventory management. Innovations such as augmented reality and the Internet of Things complement robotics solutions by offering new ways to improve the customer experience. In conclusion, the application of robotics in retail is a key element in the digital transformation process, ensuring retailers' sustainability and competitiveness in today's market.

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