



REVIEW ARTICLE

Importance of Artificial Intelligence to Improve Warehouse Processes at Óptica Pinar del Río

Pedro Acosta-Candelaria¹✉ , Claudia Permuy-Díaz² , Yaicel García-Benítez¹ ,
Yusleivy Rivers-Martínez¹ , Mayenny Linares-Río³ , Darianna Cruz-Márquez³ 

¹University of Medical Sciences of Pinar del Río. Faculty of Medical Sciences. Dr. "Ernesto Guevara de la Serna". Pinar del Río, Cuba.

²University of Pinar del Río. "Hermanos Saíz Montes de Oca". Pinar del Río, Cuba.

³University of Medical Sciences of Pinar del Río. Pinar del Río, Cuba.

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ABSTRACT

Introduction: the use of Artificial Intelligence (AI) in storage procedures is transforming the sector, opening the doors to a new era of smart warehouses. These innovations make it possible to achieve extraordinary levels of efficiency, accuracy, and optimization, resulting in dynamic, agile warehouses capable of quickly responding to future demands.

Objective: to determine the importance of AI in improving the processes carried out in the Optical and Auditory Warehouse of the Province of Pinar del Río.

Methods: a documentary review was conducted on AI applied to the Provincial Optical and Auditory Warehouse, with the aim of optimizing warehouse processes. This included bibliographic review articles and original research, as well as the methodology used. Articles of sufficient timeliness and scientific quality were selected.

Results: in general terms, the relevance of AI for the Provincial Optical and Auditory Warehouse of Pinar del Río Province is highlighted, paving the way toward a future full of changes and challenges. This objective is achieved through the automation of tasks and activities, as well as the reduction of manual processes.

Conclusions: the pressing need to implement new mechanisms in warehouses that turn them into smarter spaces powered by AI has been confirmed. These systems will have the capacity to optimize efficiency in order-picking routes, achieving this goal through task and activity automation, while minimizing manual processes.

Keywords: Warehouses; Processes; Artificial Intelligence.

INTRODUCTION

AI refers to machines designed to replicate various functions of human intelligence. This includes the ability to perceive, learn, reason, solve problems, interact through language, and even generate creative products.⁽¹⁾

Globally, this technology has consolidated as one of the most advanced, capable of learning and analyzing data in real time. It has become a fundamental tool for supply chain management and business growth, acting as a transformation catalyst thanks to recent advances in smart warehouses. AI not only optimizes operations but also offers the necessary tools to conceive and serve more effectively in warehouses. In a constantly evolving market, improving processes and optimizing operations has become essential to maintain competitiveness.⁽²⁾

It is essential to advance toward the development of smart warehouses, supported by AI, as a solution that optimizes all operational processes in this field. The implementation of these warehouses not only improves logistics but also has a significant impact on the industrial sector, commerce, customer service, and even the social sphere.

The challenges associated with this transformation go beyond the simple reduction of costs and the increase in efficiency. They encompass crucial aspects related to the economy, society, and the environment. This advance has been possible thanks to the growing integration of digital systems, thus marking the beginning of a true industrial revolution.⁽³⁾

Today, warehouse automation, including those for optical and auditory equipment, is an essential tool, but AI takes that functionality even further. This innovative technology replicates human thought and actions, with algorithms so powerful that they can process and understand large volumes of data agilely. Based on this information, AI can offer valuable recommendations, even suggesting adjustments to the physical arrangement of goods within the warehouse.⁽⁴⁾

In such a complex environment, AI acts as a catalyst that makes the system more fluid and efficient. By maximizing the utilization of all available resources, AI interconnects the logistics chain to a greater extent, improving product tracking and increasing overall performance. As the world continues its transformation at a vertiginous pace, warehouses that integrate AI are on their way to becoming leaders in their sector.⁽⁵⁾

Many companies, such as iFood, the leading delivery platform in Brazil, have reached a significant milestone by achieving 100 million orders in a single month. This success has been largely driven by the implementation of AI. On the other hand, the growth of AI companies in Latin America presents an optimistic outlook, with Brazil, Chile, and Mexico standing out as leaders in this trend.^(6,7)

In our country, the development of AI is on the government agenda. In an exchange with members of the Academy of Sciences of Cuba, President Miguel Díaz-Canel in 2024 requested the elaboration of the AI Strategy. Along this line, in October 2023, the International Institute for AI Research in China was inaugurated, with Cuban participation; it is part of a project conceived since 2019 by the University of International Studies of Hebei, with the collaboration of several universities on the island, among them those of Camagüey, Villa Clara, Cienfuegos, and Havana. They have contributed to development in areas such as biotechnology and biomedicine, environment, renewable energy, quality of life, smart cities, precision agriculture, industry 4.0, and telecommunications. Another project that bets on the development of AI-based software makes a difference in Cuba: the company Datalisoft, which celebrates its second anniversary of creation this November 30. Also present is "Plataformia," a new AI tool for local businesses.^(8,9)

When conducting an exploratory study on the importance of using AI to improve the processes carried out in optical and auditory warehouses in the country and the province, the scarce use of AI techniques in this field was demonstrated. Considering the above, this work aims to: determine the importance of improving the processes carried out at the Optical and Auditory Warehouse of the Province of Pinar del Río with the help of AI.

METHODS

A documentary review was conducted on AI applied to optical and auditory warehouses in the sector, in the Scopus, SciELO, Redalyc, Latindex, REDIB, Virtual Health Library, Dialnet, and Lilacs databases. For the search, the words: artificial intelligence; warehouse; processes in Cuba were used; for this, the logical Boolean operator OR was used, which allowed all words to appear in the results, indifferently.

All bibliographic review articles or original research that addressed some aspect associated with AI applied to warehouses that were optical or others in the sector, written in Spanish or English, through a methodology with scientific rigor, that responded to the research objective proposed in this study, were included. For content analysis, information was categorized, which allowed precise identification of the place where the research was conducted, the methodology used, the results, and the conclusions obtained. Finally, 24 articles with sufficient currency and scientific quality were selected.

DEVELOPMENT

AI goes beyond being simply a buzzword; in reality, it refers to the ability of machines, software, and technologies to process and relate information in a manner similar to human intelligence. AI presents itself as a powerful tool that allows machines to carry out tasks that previously required human intelligence. This ability confers upon them the capacity to plan, reason, communicate, and learn autonomously, which notably increases efficiency and profitability.⁽¹⁰⁾

For those who do not use it daily, AI may seem associated with Hollywood stories or the works of authors such as Philip K. Dick and Isaac, whose influence has permeated popular culture. However, the reality is that it is a set of technologies, some of them almost a century old, that are deeply integrated into our lives and that offer very effective solutions to procedures we perform without realizing it.

When mentioning that AI has almost century-old origins, we refer to the fact that its genesis dates back to the 1930s, thanks to the work of a key figure in the development of what we now know as new technologies: Alan Turing.

Alan Turing is not only recognized as the father of AI but also as one of the pioneers of modern computing. In the first half of the 20th century, he developed a variety of innovative solutions based on computing and the use of algorithms, intended to foresee and prevent various situations.⁽¹¹⁾

From its beginnings until the Dartmouth conference of 1956 where the term was formally coined, AI was explored by various authors, including Turing, McCarthy, Minsky, and Shannon. Although their opinions did not always fully coincide, they shared a common vision regarding the characteristics and functions of this process.^(12,13,14)

With the aim of improving both its storage capacity and customer service, Yamazen, a distributor of machines and tools, has inaugurated new offices and logistics facilities in Elk Grove Village, Illinois, United States. To achieve these objectives, the company has implemented the Easy WMS management system from Interlake Mecalux, together with the Slotting module to optimize the distribution of goods and the Supply Chain Analytics Software module that allows them to control every aspect of the supply chain.⁽¹⁵⁾

For its part, the fashion store Espace des Marques has restructured its two warehouses located in La Boissière-des-Landes (France) during the pandemic, in order to improve its growth opportunities and increase efficiency in order management.⁽¹⁶⁾

The dairy products company Producers Dairy has equipped its cold storage warehouse with the semi-automatic Pallet Shuttle system from Interlake Mecalux. This semi-automatic Pallet Shuttle system uses a motorized cart to facilitate the agile entry and exit of goods from their locations.⁽¹⁷⁾

The production plant of the German multinational BASF in Brazil has incorporated digitalization into its logistics. This chemical company has implemented the Easy WMS management software from Mecalux in one of its warehouses, with the aim of supervising in real time 100 % of the movements of its 1,800 references. Since its inauguration in the year 2000, the BASF factory in Indaiatuba, located 110 km from São Paulo, Brazil, has experienced constant renovations, introducing improvements that seek to optimize the efficiency of its processes. Recently, the company has equipped one of its warehouses with the Easy WMS warehouse management software from Mecalux.⁽¹⁸⁾

Experion, Honeywell's Process Knowledge System (PKS), is carrying out a restructuring of its warehouse operations through the implementation of innovative AI-based automation, which allows optimizing processes and establishing new standards of customer satisfaction in the current dynamic business environment. Over time, automation in warehouses has progressed from basic mechanized systems to fully automated solutions that use AI, capable of integrally transforming the supply chain. Originally focused on reducing manual labor and increasing productivity, this field has entered a new stage, driven by AI.⁽¹⁹⁾

One of the most palpable changes that AI brings is warehouse automation due to its complexity in supply chains regarding rapid deliveries, providing a new way to leverage data potential, improving agile adaptation to changing scenarios, increasing prediction capacity, and allowing the automation of tasks that traditionally required human intervention. Furthermore, AI-based solutions are improving rapidly and are becoming increasingly accessible, without the need for exorbitant investments.⁽²⁰⁾

Currently, Cuban industries strive to achieve logistical integration, considering this aspect as key to remaining competitive in a constantly expanding market, where the supply of products and services grows at an accelerated pace. This reality has highlighted the need to develop tools that facilitate said integration, as well as to carry out a meticulous analysis and efficient design of the logistics system. All this in order to adapt to the demands and needs of companies in the current context.⁽²¹⁾

In the vertiginous world of e-commerce and logistics, the incorporation of AI in an optical warehouse represents a significant advance. From its appearance in the digital environment to its use in multiple industrial sectors in storage, AI is demonstrating its potential to revolutionize processes, anticipate situations, and improve resource utilization. In this framework, warehouse management is configured as an ideal activity for the adoption of this innovative technology. Thus, possibilities are expanded regarding operational efficiency and the formulation of strategic decisions.⁽²²⁾

Benefits and impact of AI in warehouses:

- Smart demand forecasting and inventory optimization

Through AI algorithms, companies can analyze historical data, identify market trends, and consider other key factors to develop accurate forecasts about demand. This prediction capacity, driven by AI, allows warehouses to continuously optimize their processes in the supply chain. Furthermore, it facilitates anticipation of possible changes in demand, which helps them make informed decisions in crucial areas such as procurement, transportation, and inventory management.

- Predictive maintenance and equipment performance improvement

One of the most notable benefits of AI in warehouse management is related to the most crucial aspect of any operation: equipment. Thanks to AI, it is now possible to accurately predict possible failures and evaluate the maintenance needs of equipment through the analysis of real-time data from sensors and monitoring systems.

By adopting predictive maintenance strategies, warehouse managers can significantly reduce downtime, decrease costs associated with maintenance, and guarantee optimal performance of critical machinery and infrastructure.

- Logistics improvement

Smart warehouses, powered by AI algorithms, are capable of optimizing efficiency in order preparation routes. This optimization is carried out by taking into account various variables, such as product characteristics, the frequency with which orders are prepared, and their priorities in real time. Thanks to this intelligent planning and the optimization of travel routes, greater precision in deliveries is achieved, productivity is increased, and costs associated with labor are reduced.

- Innovation in robotics and automation

AI-powered robotics and automation technologies are revolutionizing warehouse operations. Autonomous mobile robots and robotic solutions for piece picking are examples of how these intelligent systems can navigate aisles, locate specific items, and carry out tasks quickly and efficiently, such as picking, sorting, and packaging.

The integration of AI-based robotics into warehouse workflows not only increases productivity but also improves safety and reduces human errors. A clear example of this synergy is the combination of ElementLogic's robotic picking technology, known as eOperator, with the AutoStore solution. This collaboration ensures a safe and precise picking process, optimizes labor use, and improves the supply chain, thus evidencing high profitability and a rapid return on investment in warehouse automation.

- Real-time visibility and merchandise tracking

Tracking technologies and sensors, such as computer vision, radio frequency identification (RFID), and IoT devices, combine their potential with the power of AI to offer real-time visibility of warehouse operations. These digital tools allow warehouses not only to precisely locate assets but also to monitor inventory levels and identify possible bottlenecks in processes. This greater visibility and transparency in operations simplifies decision-making, allowing it to be more agile and proactive, which in turn contributes to more efficient problem-solving and a notable improvement in warehouse operations.

- Continuous improvement and process optimization

AI-based systems have the capacity to carry out constant data analysis, monitoring key performance indicators and detecting areas that can be improved in processes. Likewise, by leveraging the knowledge generated by AI, warehouses can optimize their workflows, identify operational inefficiencies, and foster a culture focused on continuous improvement and operational excellence.

- Greater safety

AI-powered automation not only optimizes warehouse management but also reinforces worker safety and improves material handling. This technology allows exhaustive analysis of safety data, meticulous tracking of storage parameters, and fosters preventive maintenance. All this ensures rapid responses to maintain compliance with safety standards and current regulations. Likewise, by reducing dependence on manual work, the risk of accidents is minimized, as workers are less exposed to potentially dangerous situations.⁽²³⁾

-Automation and operational efficiency

Automation has become one of the most evident changes generated by AI. Warehouses can now adopt systems that function autonomously, covering everything from merchandise handling to inventory organization. Robots equipped with intelligent algorithms are capable of identifying, moving, and storing products quickly and precisely, which reduces human errors and optimizes the use of available space.

This advance not only elevates efficiency but also allows an increase in operational capacity without the need to increase labor costs.

-Predictive analysis and inventory optimization

One of the main advantages of AI in the field of storage is its ability to foresee demand through predictive analysis. By evaluating historical data and consumption patterns, AI systems are capable of anticipating changes in demand, which allows warehouses to adjust their inventory levels more effectively. This capacity reduces the risk of running out of stock or having an excess of products, which, in turn, decreases costs associated with storage and improves cash flow.

Furthermore, AI can detect those products that move slowly or that require urgent rotation, thus optimizing the internal organization of the warehouse and facilitating strategic decision-making in inventory management.

-Real-time traceability Another fundamental impact of

AI is its ability to offer real-time traceability. AI-powered monitoring systems can follow every movement of goods within the warehouse, providing detailed data on their location and status. This is especially valuable for perishable or delicate products, such as food and medicines, where it is crucial to maintain specific temperature or humidity conditions.

Thanks to this visibility, companies can proactively manage any inconvenience that arises, such as delays or inadequate conditions, thus guaranteeing that products reach their final destination in the best possible conditions.

-Sustainability and cost reduction AI plays a crucial role in sustainability. By optimizing space use and reducing waste, companies manage to minimize their environmental footprint. Furthermore, by anticipating demand with precision, unnecessary waste is avoided, which contributes to making the supply chain more sustainable.

On the other hand, the efficiency provided by AI also helps reduce operational costs. Thanks to more automated processes and decisions based on data, companies in the logistics sector can operate more effectively with fewer resources, which, in turn, increases their profitability.⁽²⁴⁾

Based on the results obtained, it can be affirmed that the use of AI in warehouses is indisputable. AI plays a fundamental role in the automation and optimization of inventory, as well as in the traceability and sustainability of operations. These benefits radically transform logistics activities within warehouses. The intelligent interconnection of processes and products allows us to conclude that these technologies are essential to improve efficiency, reduce costs, and provide higher quality service to our customers.

CONCLUSIONS

Post-analysis of all the information obtained leads to the conclusion that the importance of AI for improving the processes carried out at the Optical and Hearing Care Warehouse of the Province of Pinar del Río is demonstrated. This allows people to adapt their environment to their needs, thus facilitating life in society. It has been shown that the devices with which we interact daily are the result of innumerable modifications in our environment, and this trend will continue to increase in the coming years, where the appearance of new and better technological tools is anticipated. In particular, in Cuban warehouses, such as the Provincial Optical and Hearing Care Warehouse of the Province of Pinar del Río, AI will have a significant impact in the future, generating as many changes as challenges.

Conflict of Interest

The authors declare that there is no conflict of interest.

Author Contribution

All authors participated in conceptualization, formal analysis, project administration, writing – original draft, writing – review, editing, and approval of the final manuscript.

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