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ỨNG DỤNG ROBOT TRONG HOẠT ĐỘNG LẤY HÀNG Ở KHO VÀ NGHIÊN CỨU TRƯỜNG HỢP CỦA WALMART

Nguyễn Thị Linh Chi[1], Nguyễn Xuân An, Trần Ngọc Anh, Nguyễn Minh Thư

Sinh viên K60 Logistics và Quản lý chuỗi cung ứng - Viện Kinh tế & kinh doanh quốc tế

Trường Đại học Ngoại thương, Hà Nội, Việt Nam

Nguyễn Thị Yến

Giảng viên Viện Kinh tế và kinh doanh quốc tế

Trường Đại học Ngoại thương, Hà Nội, Việt Nam

Tóm tắt

Bài nghiên cứu này tập trung vào việc sử dụng công nghệ robot của Walmart trong hoạt động lấy hàng và những công nghệ mới tác động đến việc quản lý chuỗi cung ứng tại công ty. Nghiên cứu thảo luận về một số loại hệ thống robot: hệ thống lưu trữ và truy xuất tự động (AS/RS) và robot di động tự hành (AMRs). Bài nghiên cứu đưa ra những đánh giá về cách Walmart triển khai các công nghệ này, trước tiên bằng việc đánh giá tổng quan về chuỗi cung ứng và sự phát triển của quản lý chuỗi cung ứng tại Walmart, và tìm hiểu cách thức hoạt động của Alphabot, cơ chế của AS/RS và chuyển động của AMRs. Đánh giá về ứng dụng của loại công nghệ này trong các trung tâm xử lý đơn hàng của Walmart cho thấy công nghệ này đã góp phần nâng cao năng suất, công suất và tần suất sử dụng tại các cơ sở của công ty. Nghiên cứu cũng đưa ra bảng phân tích SWOT toàn diện và thảo luận về việc sử dụng hệ thống robot lấy hàng tự động trong các doanh nghiệp Việt Nam. Ngoài ra, bài nghiên cứu cũng đưa ra những nhận định về triển vọng tương lai của thị trường này tại Việt Nam, và những tác động khi áp dụng công nghệ robot trong quy trình lấy hàng trong tương lai khi thị trường Việt Nam có nhiều sự phát triển và thích ứng hơn.

Từ khóa: hoạt động lấy hàng, Walmart, Alphabot, AMR

ROBOTIC APPLICATION IN ORDER PICKING: THE CASE OF WALMART

[1] Tác giả liên hệ, Email: k60.2113530004@ftu.edu.vn

Abstract

This research focuses on Walmart's utilization of robotic technology in the order-picking process and the new developments impacting the management of the supply chain. The study discusses a few types of robotic systems: Automated Storage and Retrieval Systems (AS/RS) and Autonomous Mobile Robots (AMRs). The research also looks into how Walmart deploys such technologies, starting with a brief overview of the supply chain and the evolution of supply chain management at Walmart. It is through the operational representations of Alphabot that both the mechanisms of the AS/RS and the motions of the AMRs are shown. Evaluations of these robotic applications in Walmart's fulfillment centers show that such technologies could raise productivity, capacity, and utilization frequency at the company's facilities. Concluding the paper is a comprehensive SWOT analysis and a discussion of the use of robotic order-picking systems in Vietnam's businesses. In addition, the study discusses the future prospects of this niche market. It clearly spells out how robots have revolutionized the order-picking process and how these impacts may be expected in the future in terms of more developments and adaptations in Vietnam's market.

Keywords: Order-picking, Walmart, Alphabot, AMRs

1. Introduction

The retail landscape is undergoing a significant transformation driven by the exponential growth of digital technologies. This surge in online shopping has led to heightened consumer expectations for faster and more cost-effective delivery options. Consequently, fulfillment centers face immense pressure to ensure efficient and accurate order picking processes. Traditionally, this function relied heavily on manual labor, which inherently possesses limitations in terms of speed and scalability.

Recognizing these limitations, forward-thinking companies like Walmart are pioneering a new era of warehouse automation by integrating robotics into their order picking operations. By choosing the topic: "Robotic application in order picking: The case of Walmart", this research paper investigates the implementation of robotic order picking technology within Walmart's warehouses. Furthermore, the paper will conduct a comparative analysis of Vietnam's current adoption of warehouse robotics. Several issues will be addressed in the report's content: (1) How robotic technology be applied in Walmart's warehouse order picking process? (2) What are the advantages of applying those technologies (3) What are some relations to Vietnam's robotic application in warehouses?

2. Theoretical framework

2.1. Order picking

2.1.1. Definition of order picking

According to Cambridge Dictionary (n.d.), order picking is "the process of taking goods that have been ordered from the place where they are stored and sending them to customers".

2.1.2. Characteristics of order picking

- Order picking is the most costly activity in today's warehouse management due to its labor-intensive and time-consuming nature. Workers spend considerable time retrieving items, which increase labor costs. Ensuring high accuracy to prevent errors requires investment in training and supervision. The complexity of varied order sizes and requirements complicates the process, often requiring retrieval from different locations. High costs also arise from initial investments and maintenance of technology and equipment, such as warehouse management systems and automated picking technologies. Optimizing storage layouts and maintaining effective inventory management systems add further expenses, making order picking a significant cost driver in warehouse operations.

- Common errors in order picking include omitting items, sending incorrect items, and dispatching an incorrect quantity. To mitigate these errors, managers are looking for quick response times, high accuracy rates, and high productivity while minimizing expenses.

- Robotic order picking systems, which will be discussed later, offer a promising solution to address these challenges. By automating the picking process, these systems can significantly reduce error rates, improve efficiency, and ultimately optimize warehouse operations. This technology aligns with the goals of achieving precision and productivity while controlling expenses.

- Two methods in order picking are:

- Pick to order: workers manually retrieve items from storage locations based on individual customer orders. This process can be time-consuming as it involves locating specific items throughout the warehouse

- Goods to picker: utilizes automated systems to bring items directly to the picker, reducing the time and effort required for retrieval.

● Each method offers its own advantages and is selected based on factors such as warehouse layout and order volume.

2.2. Robotic order picking systems

2.2.1. Definition of robotic order picking system

A robotic picking system is an order fulfillment system that uses robots and warehouse execution system software to automate all or part of the picking process. (inVia Robotics, 2019)

2.2.2. Types of order-picking robots

The picking robots are categorized into 2 main types: Automated Storage and Retrieval Systems (AS/RS) Robots and Autonomous Mobile Robots (ARMs).

2.2.2.1. Automated Storage and Retrieval Systems (AS/RS)

An automated storage and retrieval system (AS/RS) is a generic term for a system that automatically stores items in a repository and can also retrieve them. Automated storage and retrieval system technology varies, and can consist of shuttle and robot-based, cranes, carousels,

vertical lift modules (VLMs), micro-loads, mini-loads, unit-loads, robots, or other systems. It is often integrated with a warehouse execution software (WES), warehouse management software (WMS), or other controls.

AS/RS robots retrieve items from storage and deliver them to a designated picking station for human workers, maximizing warehouse space utilization and increasing throughput while reducing manual interaction with high shelves.

2.2.2.2. Autonomous Mobile Robots (AMRs)

AMRs are self-navigating robots that move freely within a warehouse environment. Equipped with sensors and algorithms, they can transport goods, pick items, and collaborate with human workers.

AMRs can be used for various tasks, including:

- Goods-to-Person (GTP): Delivering shelves, totes, or bins containing required items to picking stations.
- Put-away: Transporting items from receiving areas to designated storage locations.
- Replenishment: Restocking picking stations with fresh inventory.

AMRs' scalability and flexibility allow them to adapt to changing order volumes and product assortments. They typically require a lower upfront cost compared to AS/RS and can collaborate with human pickers to enhance overall efficiency. However, AMRs generally have lower weight capacities than AS/RS cranes, and their navigation might require warehouse modifications.

3. Analysis of Walmart's Robotic Application

3.1. Overview of Walmart

3.1.1. Company profile

3.1.1.1. Walmart establishment and development

According to Walmart's official website (n.d.), Sam Walton's visionary leadership laid the foundation for Walmart, which began with a single store in Rogers, Arkansas, in 1962. His commitment to customer satisfaction and low prices spurred the company's growth. In 2024, Walmart operates more than 10,500 stores and numerous eCommerce websites in 19 countries while employing 2.1 million associates around the world, dedicated to helping communities save money and live better (Walmart, n.d.). Through innovation and expansion, Walmart continues to impact lives worldwide by providing affordable goods and services.

Walmart operates through various store formats including (Walmart, n.d.):

- Walmart Supercenters: Walmart Supercenters provide a comprehensive shopping experience by combining a grocery store with fresh produce, bakery, deli, and dairy sections alongside departments for electronics, apparel, toys, and home furnishings. Many Supercenters operate 24/7 and often feature additional specialty services such as banks, hair and nail salons, restaurants, and vision centers.

• Walmart Discount Stores: Smaller than Supercenters, Walmart discount stores offer a variety of products including electronics, apparel, toys, home furnishings, health and beauty aids, and hardware, all within a well-lit, open space.

• Walmart Neighborhood Markets: designed with a smaller footprint, cater to communities needing a pharmacy, affordable groceries, and merchandise. These stores provide fresh produce, meat, dairy products, bakery and deli items, household supplies, health and beauty aids, and a pharmacy.

• Sam's Club: Membership-only warehouse clubs.

• eCommerce: As one of the largest brick-and-mortar retailers globally, Walmart is also a rapidly growing and dynamic e-commerce entity. With 90% of the U.S. population living within 10 miles of its stores, Walmart is uniquely positioned to integrate its physical locations with its e-commerce operations, offering unprecedented convenience. This integration allows customers to shop anytime, anywhere, ensuring they receive exactly what they need, when they need it.

3.1.1.2. Mission and vision

Walmart's mission:

- Walmart's mission is "helping communities save money and live better all over the world" (Walmart, n.d.). This mission emphasizes Walmart's focus on offering low prices to help customers improve their quality of life. The core of their business strategy revolves around providing value through competitive pricing, a wide range of products, and a positive shopping experience, whether in physical stores or online.

Walmart's vision:

- Walmart's vision is to "to build a better world - helping people live better and renew the planet while building thriving, resilient communities." (Walmart, n.d.). This vision guides the company's efforts to integrate environmental sustainability and community support into its operations. Walmart strives to create opportunities, promote sustainability, advance diversity, equity, and inclusion, and strengthen community bonds. Ultimately, they focus on helping customers save their hard earned money for what matters most to them. Living better is central to Walmart's vision, and they work towards this goal daily. By focusing on these areas, Walmart aims to improve the quality of life for its customers and employees while promoting environmental stewardship and economic sustainability in the communities it serves.

3.1.2. Introduction to Walmart's Supply Chain and Order picking activities

3.1.2.1. Walmart's Supply Chain Overview

Walmart has benefited from lower product prices, lower inventory carrying costs, increased in-store variety and selection, and extremely competitive customer pricing as a result of its supply chain management strategy. With thousands of stores and distribution centers globally, Walmart is one of the largest retailers in the world, with a supply chain renowned for its efficiency, responsiveness, and cost-effectiveness. By implementing automation and cutting-edge technology, the company demonstrated how the expanded item storage capacity enables

the distribution center to offer a more reliable, predictable, and superior delivery service to both retailers and consumers, while also being able to respond promptly to client demand.

Regarding the *procurement* function, Walmart effectively cultivates strong relationships with all of its suppliers through the implementation of a robust Supplier Relationship Management (SRM) system. Through the cultivation of excellent supplier relationships, Walmart can sustain a resilient and varied supplier foundation, guaranteeing a consistent supply of items to fulfill the expectations of its customers.

Moreover, Walmart utilizes a vendor-managed inventory approach for *inventory management*. This model enables suppliers to retrieve data from Walmart's information system, providing them with information on stock levels and other relevant data. Suppliers will ship the necessary materials after verifying that the inventory has become scarce or empty. It also demonstrates that Walmart uses the JIT or Just-in-Time inventory strategy in which suppliers will supply the appropriate goods at the right time, that is just when the company needs additional supplies, such as when they are about to start another production process.

In its *order fulfillment and delivery* function, Walmart employs the cross-docking management technique, whereby products are immediately transferred from manufacturers to customers after being picked up. This measure is implemented to avoid the accumulation of inventory in warehouses and Walmart stores. The cross-docking management system enables customers to shortly obtain the products they purchase, hence reducing lead times.

In terms of *technology applications* in Walmart SC, besides investing in different facilities or plants, Walmart has always paid attention to investing in cutting-edge technologies that have been applied successfully in its operations. The company also has a dedicated center for research and development technology to serve both internal operations and external customers. The figure below illustrates the adoption of automation, including robotics, in different functional areas of the chain network.

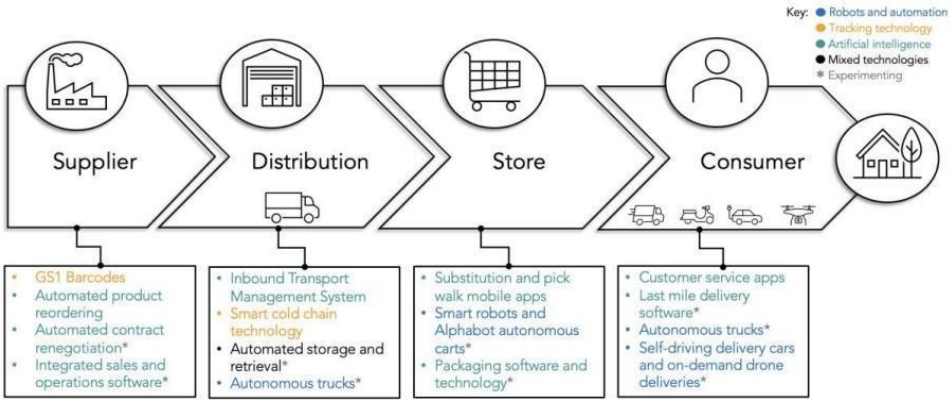

Figure 1: Walmart‘s adoption of Supply Chain Automation

Source: Stopford, N. and O’Reilly, J. (2022)

Robots and automation refer to robotic systems used across warehousing, fulfillment, and delivery operations. Tracking technologies include labels, sensors, and networks that enable supply chain visibility. Artificial intelligence refers to software that enables tasks to be performed without human intelligence. From this figure, we can notice the effort of testing and

applying different technologies to benefit the flow of work in Walmart's supply chain.

Walmart's supply chain has shifted from a relatively straightforward operation of moving products from suppliers, through distribution and into stores and onto customers, into a complex operation that now serves a more diverse set of locations to deliver these goods to consumers through growing e-commerce channels. To meet the new demand for online services it has opened 'dark' store operations and Micro-Fulfillment Centers/ or Market Fulfillment Centers (MFCs) to support the growing use of its pickup and home delivery services. Combined with its existing Distribution Centers (DCs), Walmart created an enormous network to fulfill both in-store and online channels.

Dark stores are highly automated mini-warehouses that are organized and operate like stores but are closed to customers. MFCs are compact fulfillment centers with dedicated inventory of popular items for online customers, built-in or added to a Walmart store to increase capacity and improve the customer & associate experience leverage existing stores to increase online order fulfillment. (Walmart, 2023) Walmart is also considering working with select suppliers to deliver their merchandise directly to MFCs, which it says will improve efficiency.

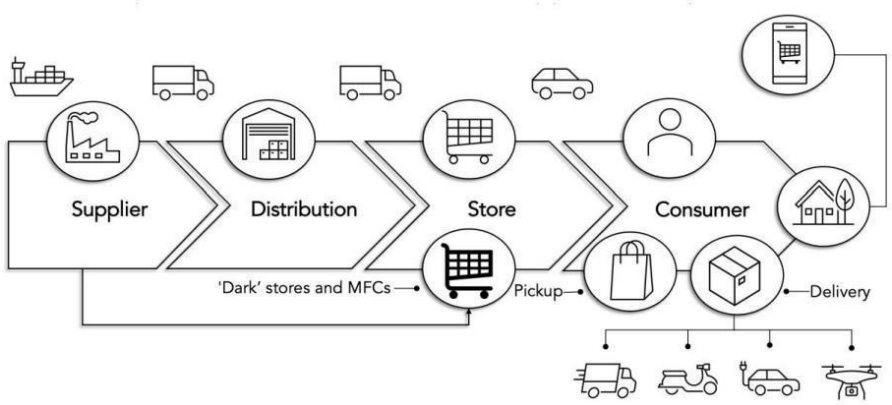

Figure 2. Walmart's Evolving Supply Chain

Source: Stopford, N. and O'Reilly, J. (2022)

3.1.2.2. Order-picking Activities

- These activities used to be known as tied with human labor, but now can be assisted by technologies, especially with robotics. Autonomous movement of crates and pallets, and advances in automated arms to grasp and manipulate individual items will lead to automating complex order-picking operations.

In distribution centers

- Different types of robotics have been applied by the company throughout the RDCs, with the plan of implementing robotics in all 42 RDCs since July 2022. From robotics unloading forklifts, and packing pallets, to picking forklifts; all of the technologies are being exploited first at some of the most 'high-tech' fulfillment centers before widespread adoption. Prior to the implementation, products that arrive at one of their RDCs are either cross-docked or warehoused until there is demand for them; and these products are moved or stored manually.

When it’s time for the product to go to a store, someone is tasked with picking and packing for transit. When the truck arrives at a store, the employees then unload it manually and get the items where they need to be.

- However, until 2021, the technology from Symbotic applied the system that uses a complex algorithm to store cases like puzzle pieces using high-speed mobile bots – operating with a precision that speeds the intake process and increases the accuracy of freight being stored for future orders. (Metzger, J., 2021) By using dense modular storage, it also expands building capacity, and with these high-speed palletizing robotics to organize and optimize freight, it can pick products from the orders and create custom store- and aisle-ready pallets, which take the guesswork out of unloading trucks.

In fulfillment centers

- Automated picking systems work with manual picking efforts to efficiently handle large volumes of orders, minimize shipping times, and reduce costs. The MFCs are powered by automation from the company Alert Innovation, which was acquired by Walmart in 2022. Walmart is using its stores as fulfillment centers, and the Alert Innovation system installed by Walmart can also hold thousands of items, from canned goods to fresh fruits and vegetables, known as Alphabot. Instead of an employee walking the store to fulfill an order from the storage shelves, automated bots retrieve the items from within the fulfillment center. The items are then brought to a picking workstation, where the order can be assembled with speed.

3.2. Walmart’s robotic application

3.2.1. Alphabot - the application of Automated Storage and Retrieval Systems

Overview of the Alphabot system

Alphabot is an Automated Storage and Retrieval System (AS/RS) and Automated Each-Picking System (AEPS), armed with a capital-efficient and broadly scalable design.

At the heart of Alphabot technology is a decentralized mobile robot which has a unique ability to operate in all three dimensions within a multilevel storage structure.

The Alphabot's patented robotic fleet is used to accomplish tasks through a single Master Control System (MCS), which is the brain of Alphabot system. MCS is responsible for processing all orders, scheduling all bot tasks, managing all bot moves to optimize flow and throughput while preventing collisions between bots, and interfacing to the world outside of the system. It offers vertical-drive mechanisms that allow the robots to travel vertically as well as horizontally, resulting in a space saving structure and a more efficient material handling process.

Operations of the Alphabot system

The automated bot, dubbed Alphabot, will retrieve items from the fulfillment center's storage system and bring them to an associate at a picking station. The system holds inventory separate from the store floor.

The picking station will then use "pick to light" technology, using lights to guide the associate to which item to pick and which bag to place it in.

The Alphabot system is designed to be flexible, scalable, and efficient, using a combination of mobile robots, modular storage totes, and proprietary software to automate the warehouse operations. The robots uniquely travel in three dimensions within a multilevel storage structure, retrieving items and delivering them to a picking station where associates can efficiently prepare the customer orders. There are no moving parts in the alphabet storage structure for maximum reliability and for lowest maintenance cost. At the heart of the system are our alphabet robots omnidirectional, battery free robots that charge on the fly for maximum system uptime and safety. Because the robot is the only moving part in the structure with various travel paths, there is no single point of failure. The passive bot storage structure is scalable for different real estate and product assortment requirements.

A simple interface and multiple sensors are used to minimize training needs and maximize rate of decant and order dispense. Alphabot robots present inventory to store associates at the workstation to fulfill customer orders. These stations operate at eight to 10 times the manual pick rate with multiple sensors and software features to ensure picking accuracy.

Besides, these bots are in motion in addition to a highly innovative picking workstation which picks goods letting bots themselves maneuver through these workstations, and these pickers transfer items from product containers to order containers. The robots are mounted vertically, and the workstations arrayed at multiple vertical elevations, enabling unprecedented space efficiency in high-throughput systems.

There are four forms of structure within which the bots operate within an each-picking system:

(1) storage modules that hold totes in storage, within which the bots move linearly and at relatively high velocity,

(2) tower modules containing vertical tracks with which the bots engage to move vertically,

(3) decks on which bots move two-dimensionally to access aisles and workstations, and

(4) picking workstation modules in which bots present totes to pickers who transfer eaches from product totes to order totes. Aisle and tower modules are assembled quickly and precisely at ground level through the use of assembly fixtures and are then raised into place, stacking one on top of another. The entire structure is thus erected very quickly and with high dimensional precision.

Benefits of using the Alphabot system in Walmart's warehouses

- Increased efficiency: Alphabot achieves significantly faster pick rates (800+ picks per hour) compared to manual picking. Besides, Alphabot enables near-immediate order delivery (95% of orders are fulfilled in 12 minutes).

- Improved accuracy: Accuracy is ensured when the workstation controller uses an overhead projector to illuminate both the pick and put locations (pick-to-light and put-to-light), and sensors are able to detect the location of the picker's hand when making a pick or a put.

- Improve inventory control: Totes and sub totes allow maximum assortment, high storage

density, and precise inventory control while saving labor, the input output workstations where products enter and exit the Alpha Bot system.

• Higher return on investment (ROI): The labor savings from storing completed orders in the system and auto dispensing them delivers 40% more return on investment than traditional picking systems that rely on expensive secondary storage and manual order consolidation within the storage structure.

Overall, automating the retrieval process using the Alphabot system can significantly reduce the time and effort required for order fulfillment, improving the overall efficiency of the supply chain and increasing customer satisfaction by ensuring that orders are fulfilled accurately and quickly.

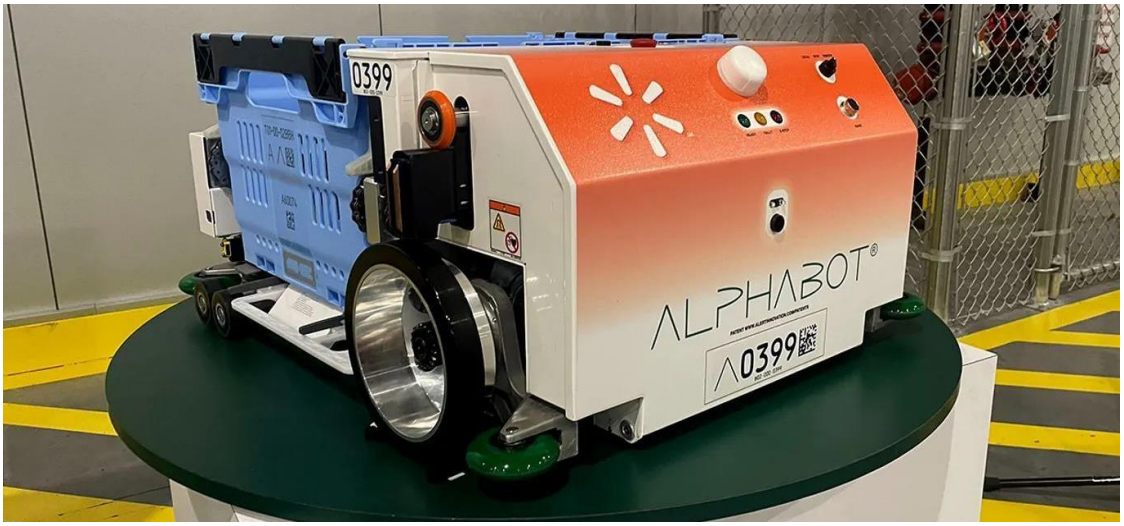

Figure 3. Walmart's Alphabot

Source: Fox Business/Fox News, 2023

3.2.2. The application of Autonomous Mobile Robots

Before 2022, items arrive at one of Walmart's regional distribution centers and are either cross-docked or stored until required (Walmart, 2021). The handling of products involves manual movement or storage. When products are due for transfer to a store, an individual is assigned the task of strategically packing a 53-foot trailer, akin to the game of Tetris, for transportation. Upon the truck's arrival at a store, the associates manually unload it and distribute the items to their respective locations within the store. However, after teaming up with Symbotic in 2022, things are done in a different way.

Operations:

The system utilizes a sophisticated algorithm to arrange cases similar to puzzle pieces, employing high-speed mobile bots. This precision enhances the efficiency of the intake process and improves the accuracy of stored freight for future orders. Additionally, through the implementation of dense modular storage, it effectively increases building capacity. Furthermore, by employing high-speed palletizing robotics to arrange and optimize freight, it generates customized pallets that are store-and-aisle-ready, simplifying the unloading of trucks by eliminating guesswork.

Figure 4. Walmart's Autonomous Mobile Robot

Source: Businesswire, 2022

Benefits of using AMR in Walmart's warehouses

• Simplified unloading process: The adoption of new methods for unloading store- friendly palletized trucks simplifies the process for associates, enabling them to allocate more time to customer service. It also accelerates product placement on shelves and streamlines processes, saving time for associates.

• Associate training and skill development: The technology presents an opportunity for associate training in equipment operation, fostering the acquisition of new skills and preparing them for future job roles.

• Reduction of manual handling: By minimizing the need for manual freight handling, the technology alleviates one of the most challenging aspects of supply chain work in material handling.

• Industry-leading change: While customers may not directly witness warehouse operations, the implementation of advanced technology reflects Walmart's commitment to innovation and improving customer experiences through efficient supply chain management. Introducing innovative technology on a large scale is groundbreaking, which proves that Walmart is aiming to address complexities in the global supply chain and maintain industry leadership.

3.3. Evaluation of Walmart's robotic application

There's a Walmart store located within 10 miles of 90% of the U.S. population. (Mohapatra, S., 2022) They have revamped some of their stores into partial e-commerce hubs, the first-of-its-kind test of combining in-person and online shopping. They have started to introduce more technology solutions to ramp up the supply chain infrastructure to expand high-tech Market Fulfillment Centers (MFCs) and build more technologically advanced

Distribution Centers (DCs).

– ***Automated Storage and Retrieval Systems (AS/RS) - Alphabot***

This has saved time for the Fulfillment Center (FC) /Distribution Center (DC) workers who traditionally walk up to nine miles per day picking items from multiple floors of shelving spread out over thousands of square feet of space. (Mohapatra, S., 2022)

In distribution centers

The unique design of the automated storage & retrieval system increases twice the volume of products that Regional Distribution Centers (RDCs) can hold, therefore making Walmart's automated RDC ship nearly double the number of cases as compared to a traditional RDC. In an automated RDC, using the AS/RS, 560 thousand cases can be shipped each day with minimal case handling by associates. Prior to automation, associates manually handled up to 300 thousand cases per day.

In fulfillment centers

Alphabot technology powers Walmart's MFCs. This technology is an advanced robotic warehouse automation system customized for online pick-up and delivery customers. After operating a a pilot location since 2019 in Salem, New Hampshire as an Automated Picking, Storage, and Dispense system; Walmart has studied and perfected the technology leading to the operation of other MFCs nationwide, including a "scaled-down" Alphabot system operating at a warehouse in Arkansas (where Walmart's corporate HQ is located) and Mustang, Oklahoma, the system was planned to be rolled out to store in and Burbank, California.

The analysis of a technology company called AnyLogic was made for Walmart to evaluate the feasibility of Alphabot and concluded that Alphabot would be able to pick up 95% of online grocery orders in less than eight minutes, with an average pick time of under five minutes. In 2022, the number of online fulfilled orders increased by 170% compared to the previous year, and that's on top of more than 500% from the year before. (FactSet CallStreet, 2022) The company also has 4,700 stores located within 10 miles of 90% of the U.S. population — for storage and fulfillment. (Walmart, 2022) Having high-tech fulfillment centers and inventory so close to so many customers is a competitive advantage, in some cases, the items are getting to customers in hours, rather than days.

– ***Autonomous Mobile Robots***

AMRs enhance productivity in warehouses, their function is the same as that of Automated Guided Vehicles (AGVs): to move materials between two points. The difference between the two lies in their navigation system. AGVs travel along a predefined path using laser- or wire-guided systems. AMRs, on the other hand, adapt their routes according to the information they receive from their environment in real time, without the use of guides, wires, or magnetic strips.

Initially, Walmart's partnership with AI supply chain tech group Symbotic and orders covered installing the group's pipeline of Autonomous Mobile Robots solutions and software automation platforms in 20 RDCs. However, in 2022, further orders followed to have an implementation across all of Walmart's 42 RDCs. (Symbotic, 2022) Although both sides have not published any detailed analysis regarding the capacity or results of implementation, the

decision to acquire an 11% stake in the Symbotic company and introduce all of its RDCs with this technology has proven that this is a success and capability of development in the future Walmart's operations.

The need for accuracy and speed in the supply chain has never been more visible, and this solution from Symbotic is to speed up the order fulfillment process and expand distribution capacity. The installed system is estimated to have a lifetime of 25 to 30 years. It can be installed in distribution centers of various sizes and shapes due to its modular design. (Symbotic, 2022) Meaning that should the customer's demand increase in the future, the system can be easily extended. A typical deployment takes around 6 to 12 months once the contract has been negotiated.

4. The potentials of robotic order picking systems in Vietnam

4.1. SWOT analysis of robotic order picking systems in Vietnam

− ***Strengths***

Growing young & tech-savvy workforce: First of all, Vietnam boasts a young and tech-savvy population. According to the data from Vietnam's General Statistics Office, by 2025, Gen Z is expected to take up about one third of the total Vietnamese workforce (PwC, 2021). This could provide a readily available talent pool for training and developing the workforce needed to operate and maintain robotic systems in the future.

The reason is that a young workforce is generally more adaptable and eager to learn new skills. This can make them easier and potentially less expensive to train for operating and maintaining Alphabot systems compared to a resistant or less tech-savvy workforce. Moreover, investing in training this young workforce for robotics creates a skilled talent pool for the long term. This ensures a readily available workforce as Alphabot adoption grows in Vietnam.

Government focus on technology: Secondly, The Vietnamese government's push towards Industry 4.0 creates a supportive environment for adopting automation solutions like robotic picking systems. In terms of financial incentives, tax breaks or subsidies can make Alphabot, despite its initial investment cost, more affordable for Vietnamese businesses. This can encourage wider adoption, especially among smaller businesses.

The government can also facilitate partnerships between Vietnamese companies and established international robotics players. This collaboration can bring valuable expertise and technology transfer to Vietnam, accelerating Alphabot adoption and potentially leading to adaptations suited to the Vietnamese market.

− ***Weaknesses***

Limited investment capital: The first difficulty comes from the limited investment capital for the information technology system and modern robotic equipment. Despite the great demand, many businesses currently do not have enough resources and strategic orientation in this investment process. Currently, Vietnam's logistics market involves numerous SMEs that provide low-value-added service. Over 90 percent of the country's 3000-plus logistics firms

have their registered capital below US$430,000 (GSO, 2020). Many investors are still concerned about the performance and cost of new technology equipment or whether an automatic system is really more optimal than the traditional warehouse with such current labor costs. Besides, Many warehouses in Vietnam, particularly those of smaller businesses, might be older and not structurally designed to accommodate robotic systems. Therefore, there are also costs of modifying the warehouse layout to adapt to the modern systems.

Lack of highly qualified human resources: In addition, to be able to apply and control modern machinery production lines require enterprises to have a team of qualified and highly technical human resources. This causes a lot of difficulties for the recruitment and training process within the organization because most of the current human resources in many factory systems do not have high technical qualifications, never worked with modern machinery and technology, but only did repetitive jobs in the production line.

Resistance to change: One notable obstacle is the resistance to change and traditional operational methods prevalent in many warehouses. The integration of robotic systems requires a shift in the mindset of warehouse operators and workers, and resistance to such changes can impede the adoption of warehouse robotics. However, according to a report by Asia Development Bank, the adoption of robots and other connected systems has created 134 million new jobs compared to 101 million jobs lost due to new technology and thereby boosted productivity and higher economic growth.

– ***Opportunities***:

The rising demand for efficient order fulfillment: According to the e-commerce data platform Metric, total sales on the country's five largest online retail platforms are forecast to reach $3.33bn in the second quarter, up 19.2% from the first three months of the year. The growing demand of online shopping together with increasingly customized requests from customers lead to the need for more efficient logistics and supply chain management, especially the phase of warehouse management. Having to handle a huge number of orders at the warehouse every day will put a lot of pressure on the warehouse labor. If steps in the order fulfillment process are performed manually, this can cause inefficiencies (lack of accuracy and speed) in order fulfillment and increase overall operating costs. This will be an opportunity for companies in Vietnam to consider using automated systems in warehouse operations, which is also an urgent requirement for businesses to operate cost- effectively and ensure service level.

Collaboration opportunities with international players: With the support in finance, regulation and policy from the government, Vietnam is attracting partnerships with big international corporations in terms of value chain & technology. Partnerships with established international companies with modern & upgraded infrastructure, technology and operations as a whole can bring expertise and technology transfer to Vietnam, accelerating the adoption of robotic order picking systems. Furthermore, collaboration can involve knowledge-sharing programs or joint training initiatives. This can help develop a skilled Vietnamese workforce for operating, maintaining, and even potentially designing future generations of robotic picking systems.

– ***Threats***:

Data security concerns: As Vietnam embraces robotic order picking systems, data security becomes a paramount concern. These systems collect and store a vast amount of sensitive information, making them potential targets for cyberattacks.

Data at risk could be inventory details when robotic systems track inventory levels and locations in real-time, customer information, or system operational data as robotic systems rely on software and data to function. A cyberattack could disrupt this operational data, leading to malfunctions and potentially halting warehouse operations.

The cause of this threat could be attributed to security gaps in the network connecting robotic system, or bugs in the software powering the robotic systems, which will lead to financial losses and operational disruption by causing delays in order fulfillment and potentially impacting customer satisfaction.

Furthermore, **concerns related to job displacement** and the need for retraining the workforce to operate and manage robotic systems create additional hurdles for the widespread acceptance of warehouse robotics in Vietnam. It is true that robotic systems are designed to automate all the manual tasks in the process, potentially leading to job losses for workers currently performing these functions. The job displacement can lead to increased unemployment and economic hardship for affected workers. Instead, the automatic system requires skillful workers in the aspect of management and technology control, which may not be compatible with the current labor's scope of work & skills.

4.2. The potentials of robotic order picking systems in Vietnam

Report Ocean, a leading strategic consulting and market research firm, in its recent study, estimated Vietnam warehouse robotics market size at USD 12.07 million in 2022. During the forecast period between 2023 and 2029, Report Ocean expects Vietnam warehouse robotics market size to grow at a significant CAGR of 15.45% reaching a value of USD 32.82 million by 2029 (Report Ocean, 2023). This proves that Vietnam enterprises have been paying attention to autonomous warehouses. However, the robotic order-picking system in Vietnam has not developed as much as many countries in the world.

There have been several companies in Vietnam that supply simpler robotic order-picking systems:

• AS/RS Cobots (Collaborative Robots): These are smaller, more user-friendly robots that can work alongside human pickers. They could handle repetitive tasks like picking small items, freeing human workers for more complex tasks.

• Vision-guided picking systems: Cameras and AI could be used to identify and pick items, particularly those with irregular shapes or barcodes that are difficult for traditional robots.

About Alphabot and Walmart ARMs, they are the most suitable for warehouses that share some characteristics:

• Frozen food storage: This is an ideal environment for Alphabot and AMRs as it can operate in cold temperatures that might be hazardous for human workers. Additionally, frozen food items are typically packaged in sturdy boxes or bags, making them easy for Alphabot to

grab and maneuver.

• Warehouses with a high volume of items: Alphabot and AMRs utilizes a camera and sensor system to navigate the warehouse and locate the products required. This makes it perfect for warehouses with a vast selection of items, allowing it to quickly find customer orders.

• High order volume: Alphabot and AMRs excel at handling multiple orders simultaneously, making it ideal for warehouses with a high order fulfillment demand.

• Large warehouse spaces: Alphabot and AMRs can efficiently move around large warehouses due to its design and navigation system.

However, in terms of cost, to develop and implement the high-technology robotic systems like Alphabot requires a very large initial investment in research, development, infrastructure and training. According to Shiphero Blog, if a company want an automated system which focuses on picking improvement, you will likely find the cost to be between $500,000 to $1 million (Shiphero, 2023). That is a big difficulty for most businesses in Vietnam, not to mention that investing in and operating high-tech robot systems like Alphabot or Walmart ARM will require a larger initial investment. Therefore, before deciding whether to automate the order-picking process, the companies need to consider the scale of operation, types of goods stored, order fulfillment requirements, return on investment, etc.

Based on these features and the scales & capabilities of companies, it will be potential to apply for the top list of the largest retailers that combined with e-commerce in Vietnam:

• *Mobile World Co. Ltd* (Công ty Cổ phần Thế Giới Di Dộng): It recorded 118,280 billion VND in net revenue and 168 billion VND in profit after tax in 2023. (Công Thương, 2024)

• *FPT Retail* (Công ty Cổ phần Bán lẻ Kỹ thuật số FPT): FRT currently owns a total of 2,252 FPT Shop and FPT Long Chau stores nationwide. In 2023, FPT Retail records accumulated revenue of VND 31,850 billion, an increase of 6% compared to 2022. (Stockbiz, 2024)

• *Saigon Co.op* (Liên hiệp Hợp tác xã Thương mại TP.HCM): In 2023, Saigon Co.op maintains sales of nearly 30,000 billion VND, of which online sales reach nearly 1,700 billion, growing 19.5% over the same period in 2022. (Tuoitreonline, 2024)

• *Mediamart* (Công ty Cổ phần MediaMart Việt Nam): In 2021, this enterprise recorded revenue of 8,592 billion VND, equivalent to 2020. However, profit after tax grew suddenly, reaching 56 billion VND compared to 21 billion VND in 2020. (Glints, 2022). By 2024, Mediamart owns 355 supermarket systems nationwide. (Mediamart, 2024)

Besides, for other companies who want to automate order-picking systems, there are some possibilities to boost the progress faster:

• Domestically Developed Systems: Vietnamese companies could develop similar systems tailored to the specific needs of the local market, potentially at a lower cost point. The potential benefits could be:

○ Technological Advancement: Drives innovation and expertise in Vietnamese robotics.

○ Market Fit: Tailored solutions might be more readily adopted by Vietnamese businesses

compared to foreign systems.

- Collaboration: Partnerships with established robotics companies could leverage Vietnam's manufacturing expertise and bring down development costs. This approach offers several advantages:
  - Technology Transfer: Vietnamese companies can gain access to expertise and technology from established players.
  - Shared Investment: The development costs can be distributed, making the project more financially viable.
  - Faster Development: Leveraging existing knowledge can accelerate the development timeline for Vietnamese robotic order picking systems.
- Start Focused, Scale Smart: Instead of a complete overhaul, companies can begin with a pilot project. They need to choose a specific area with high-demand items or frequent bottlenecks and then analyze the success and lessons learned before expanding automation to encompass the entire warehouse. This phased approach minimizes disruption and allows for adjustments.

5. Conclusion

In conclusion, this research paper underscores the significant role of robotic technology in revolutionizing the order-picking process within Walmart's supply chain management. By examining the deployment of Automated Storage and Retrieval Systems (AS/RS) and Autonomous Mobile Robots (AMRs), we have gained insights into the transformative impact of these technologies on enhancing productivity, capacity, and utilization frequency within Walmart's warehouses.

Firstly, Walmart implementing the Alphabot system to automate the retrieval process has the potential to substantially decrease the time and labor needed for order fulfillment. This enhancement can elevate the overall efficiency of the supply chain, leading to heightened customer satisfaction through precise and prompt order fulfillment. Secondly, the application of Symbotic's AMR into Walmart's warehouse speeds up the order fulfillment process and expands distribution capacity. They also enable Walmart to optimize warehouse layouts for maximum storage capacity, enhancing operational efficiency. Furthermore, the comprehensive SWOT analysis offers valuable insights into the strengths, weaknesses, opportunities, and threats associated with the utilization of robotic order-picking systems. This analysis serves as a foundation for understanding the strategic implications and future prospects of this niche market, both on a global scale and within Vietnam's market context. Looking ahead, it is clear that robotic order-picking systems will continue to evolve and adapt to meet the dynamic demands of the retail industry. As such, it is imperative for businesses, both globally and in Vietnam, to embrace technological advancements and leverage them to drive innovation and operational excellence in supply chain management.

In essence, this research paper highlights how robots have fundamentally transformed the order-picking process, paving the way for further developments and adaptations in the future.

By embracing these advancements, businesses can remain at the forefront of innovation and unlock new opportunities for growth and success in the increasingly competitive landscape of the retail sector.

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