Nikolai Savushkin

Warehouse automation in logistics: Case study of Amazon and Ocado.

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Abstract

Author(s):	Nikolai Savushkin
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The logistics industry is undergoing a profound technological transformation from manual labor to automation, driven by innovations like robotics and AI, reshaping operational dynamics. This shift towards automation is crucial for enhancing efficiency, reducing costs, and meeting evolving consumer demands.

This thesis explores warehouse automation and its impact on business performance and employees' working conditions by conducting a comprehensive analysis of two case studies – Amazon and Ocado. The study aims to address four research questions devoted to the examination of the effect of warehouse automation on business performance and work conditions, and investigate the strategies of Amazon and Ocado to understand the implications of robots in the warehouse industry. The thesis solely focuses on secondary data, obtaining information from EBSCO and Emerald databases from industry reports and online newspapers, and other online media to investigate Amazon and Ocado warehouse automation strategies. The results were analyzed using content analysis and presented in the form of text and tables, then compared with the literature review.

The findings of the study indicate that robotization significantly improves warehouse performance, resulting in higher efficiency, productivity, and faster delivery to anticipate customers' demands. Robots can take over heavy physical and monotonous tasks which allows employees to focus on more logical and complex activities. On the other hand, it raises a risk of substituting human labor in the warehouse sector, which increases stress and the number of potential injuries at the workplace. The main findings included that both companies benefit from robotization in terms of enhanced productivity and increase of sales, however, they both faced protests from employees, who are not satisfied with the changes due to the risk of losing job and safety concerns. The thesis is concluded with the main findings and recommendations for the academic world and practitioners.

Keywords: Warehouse automation, robot, Amazon, Ocado, warehouse robotization

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Glossary

AI	Artificial Intelligence – machine learning, that can complete human tasks, combining a vast of information – historical and present.
AMR	Autonomous mobile robots – can navigate the warehouse independently and display information about the orders in real-time.
IoT	Internet of Things – devices that connect and exchange data with other systems and devices.

1 Introduction

The continuous technological advancement has impacted every aspect of people's lives and business environment (Ahmed, Khan & Naidu 2020: 1; Nantee & Sureeyatanapas 2021: 2866). Different machines are already a part of the human environment facilitating the life of everyone (Wang, Ramik, Sabourin & Madani 2012: 215). The logistics industry is not an exception as innovations (e.g., robots, Artificial Intelligence (AI), Internet of Things (IoT), machine learning) shape how the sector operates resulting in a higher complexity (Perotti, Santacruz, Bremer & Beer 2022: 194). The history of this industry lies in the long-term transformation, starting from human labor, steam engine to the forklift, up to the current era of robot pickers and packers (Dekhne, Hastings, Murnane & Neuhaus 2019). It can be justified by the fast growth of e-commerce, increases in labor cost and changing demands of customers (Cai 2020: 693). The examples of such consumers' requirements consist of immediate (same-day) delivery and different options of it (e.g., courier, pick-up points, etc.), a wide range of various products available to choose from, and return options (Kembro & Norrman 2022: 107). Overall, logistics is an ever-growing industry, which reached the value of 5.6 trillion euros in 2018 with a projected compounded growth of 4.6% until 2023 (Perotti et al. 2022: 193). Besides, the sector employed about 10.3 million workers in Europe, based on the data of 2018, which in turn makes logistics an important segment for the global economy (Perotti et al. 2022: 194). The current paper overviews two particular organizations – Amazon and Ocado. It was identified that the first company takes up to 22% of the market share within the USA's parcels (Garland 2023), while Ocado's market share in retailing in the UK is 12.3% (Ocado Group 2023).

Warehousing is a low-profitable sector in logistics with high health risks for their workers, which raises a need for technological advancement to reduce costs and prevent accidents (Gutelius & Theodore 2019: 5). It is well-known that robots change business processes and impact working conditions of

employees. Work design is related to “content and organization of one’s work tasks, activities, relationships and responsibilities” (Berkers, Rispens & Le Blanc 2022: 1853). According to the same article, it is essential to take this concept into account because the correct work design can prevent potential risks, increase efficiency of robots, and ensure human workers’ well-being and performance.

At the period of 2017, 80% of logistic operations were still done manually (Mikušová, Čujan & Tomková 2017: 1). Working conditions in logistics before robotization were tough, employees had to carry heavy items and walk a lot (Berkers et al. 2022: 1862). However, the projection that robots will take over by 2025 is that 1.5 million workers in the Eurozone will be replaced by them (Roland Berger, 2016: 2). Even though completely automated warehouses exist, they still highly rely on human labour (Berkers et al. 2022: 1854). The report of Gutelius & Theodore (2019) shows that 44% of the total human labour force in warehouses is assigned to moving objects by hand (p. 19). Other occupations include truck operators, stocking and ordering functions, hand packagers, and shipping and receiving employees. All of them can be easily replaced by robots. This point confirms that the logistics industry is a labour-intensive sector that aims to operate faster and at cheaper costs (Berkers et al. 2022: 1860).

Before, warehouses were perceived as the “necessary evil” in the supply chain, which further transformed into a key element to meet customers’ needs (Kembro & Norrman 2022: 107). The function of warehouses includes accommodating better-quality services and mitigating supply and demand (Sahara & Aamer 2021: 623). In other words, warehouse operations include receiving, storing, order picking and shipping (Nantee & Sureeyatanapas 2021: 2867). Warehouses are one of the most crucial elements of the supply chain (Baker & Halim 2007: 129; Nantee & Sureeyatanapas 2021: 2867) due to its cost component (Perotti et al. 2022: 194) of 40% of the total production (Maheshwari, Kamble, Kumar, Belhadi & Gupta 2023: 1) and a direct impact on

customer service (Nantee & Sureeyatanapas 2021: 2866). The significance of this study can be explained by the fact that nowadays internal logistics does not have a sole function of distribution and transportation, but acts as a part of the internal strategic planning of organizations (Burganova, Grznar, Gregor & Mozol 2021: 553). Warehouse automation has revolutionized supply chain management, impacting the speed (Tagashira 2022: 2), accuracy, and cost-efficiency of order fulfillment processes (Baker & Halim 2007: 130), which has a further positive impact on customer satisfaction, quality of service and products, and overall company's productivity (Perotti et al. 2022: 194). Therefore, it is required for organizations to apply a high-tech element to remain competitive in the industry (Nantee & Sureeyatanapas 2021: 2866). The strategies and technologies employed by Amazon and Ocado serve as exemplars for businesses across the globe, especially taking into consideration that both companies are logistical, but operate in different niches, which allows the author to conduct a comparative analysis of the implications of warehouse automation.

This thesis aims to address the following questions:

- How does robotization affect the performance of warehouses?
- How does automation impact the work conditions of warehouse employees?
- What are the strategies and technologies used by Amazon and Ocado in warehouse automation?
- What are the implications of using robots for the warehouse industry?

The structure of the current dissertation is as follows. The first section is devoted to Introduction, where the background and the rationale of the study is explained, at the same time depicting research questions which are supposed to be answered throughout the study. The second chapter is Literature Review which reviews the theory from the academic sources to develop a conceptual

framework and derive the main concepts dedicated to the warehouse automation and robots used in warehouses, including its impact on the organizational performance and employees. The third section is Methodology, which demonstrates the methodological choices with justification. The fourth chapter is Results and Analysis that consist of the secondary study: case studies – Amazon and Ocado, including data found online on what kind of robots they implemented, what benefits and challenges they face; then Analysis subsection which presents the findings from the secondary research and contrasts with the literature. The fifth chapter is Conclusion that provides the summary of main findings and concepts, answers to the stated research questions, and lastly recommendations for both academic world and warehouses that are planning or already using robots in their operations.

2 Literature Review

This chapter overviews the literature on warehouse automation, narrowing the topic down to the use of robotic solutions in warehouse operations, and its effects on both employees and organizational performance, that would constitute a theoretical basis for further exploration of how Amazon and Ocado utilizes technologies in their warehouses and what benefits and challenges it brings.

2.1 Warehouse automation

Warehouse automation is a progressive trend growing around the world (Kembro & Norrman 2022: 108; Onal, Zhu & Das 2023: 2), which can be defined as “the direct control of handling equipment producing movement and storage of loads without the need for operators or drivers” (Baker & Halim 2007: 129). In order to overview the topic in-depth, the following sub-section will present the challenges, solutions and benefits of warehouse automation.

2.1.1 Challenges in modern warehousing

Currently, warehouses face several challenges associated with inaccuracy of inventory, cash flow restrictions (Grover & Ashraf 2023: 3), excess stocks, no safety monitoring of their workers in real-time, low visibility and connectivity, delays, product returns and low efficiency (Maheshwari et al. 2023: 2). Apart from that, warehouses become more and more customer-oriented, thus, all innovations are used to anticipate changing demands of the end-consumers (Onal et al. 2023: 2). Taking into account that with the introduction of experience economy is growing and both organizations and people expect that warehouses have to operate effectively at the short periods of time, in other words, short period of delivery from the order placing (Grover & Ashraf 2023: 1).

2.1.2 Technological solutions

Maheshwari et al. (2023) stated that all these issues can be solved by integration of robots, AI, machine learning, IoT, and block-chain technologies (p. 2). Grover and Ashraf (2023) also added robots, in particular, Internet of Things (IoT)–enabled advanced robotics (autonomous mobile robots), which are highly used for improving productivity and efficiency of warehouse operations (p. 1). Furthermore, the use of such innovation complies with the requirements of the new era – Industry 4.0 (Maheshwari et al. 2023: 6; Perotti et al. 2022: 194; Sahara & Aamer 2021: 623). Automated warehouses consist of systems which can be used for automated storage and retrieval functions, in particular, “carton alignment, case/pallet replenishment, picking systems, case sealing, case packing, case sorting, and guided vehicles” (Tagashira 2022: 2). The process of warehouse companies adopting technologies is influenced by several factors, including technological readiness, digital awareness, level of education of human employees, set of policies, and management – operational and financial decisions (Perotti et al. 2022: 201).

Modern warehouses normally have all required equipment for automation to achieve task allocation and collision-free path planning between robots to do a series of operations (Liu, Han, Wang & Xu, 2020: 1). Thus, robots can create a simulation with various scenarios and conduct analysis of them, generating outcomes such as performance metrics, response time and resource utilization (Grover & Ashraf 2023: 3). Additionally, it is required to improve decision-making processes and provide real-time data storage and sharing moving information. However, it is important to mention that the implementation process is costly and complex, which is why not many organizations are willing to adopt the innovative model of warehousing (Sahara & Aamer 2021: 623).

2.1.3 Benefits of warehouse automation

Indeed, Nantee and Sureeyatanapas (2021) pointed out that overall Industry 4.0 brought many economic benefits such as cost reduction and enhanced

productivity in warehouses (p. 2868). At the same time decreasing the lead time, which in turn has a positive effect on customer satisfaction. It was identified that application of various technologies and automation features in warehouses can lead to the increase of competitive advantage (Nantee & Sureeyatanapas 2021: 2866). Fast growth of e-commerce forces companies to work on their distribution channels to decrease lead-time and deliver items fast, even on the same day (Berkers et al. 2022: 1854). There are various solutions exist that are oriented on reducing travel time, developing the most effective routes. On the other hand, order picking is the most expensive component of total warehouse operations, it takes a half of the total (Onal et al. 2023: 2). Therefore, these authors emphasize that fulfilling centers in warehousing should not have a random storage assignment and establish clear routes for order picking, but algorithms of robots can create the best routes. The trend of shifting from “lean” warehouses (maximizing space and equipment) to delivery of high customer service has been noticed since the last decade (Baker & Halim 2007: 130), which emphasizes the importance of employment of technologies into warehouse operations for better connectivity between work tasks and all stakeholders (Maheshwari et al. 2023: 11). In addition to that, another source supported the same idea - International Federation of Robotics (2017) stated that robots improve working conditions, increase productivity and demand for qualified human capital, and therefore salaries of human workers went up. The same report mentioned that soon robots will work together with employees. That is what happened recently. Statistically, one in three workers shows a positive attitude toward working with a robotic colleague; not less than 42% of employees believe that robotization contributes to work processes and produces an added value (Lambrechts, Klaver, Koudijzer & Semeijn 2021: 4). For this reason, the next section is devoted to exploration how robots are used in warehouses.

2.2 The use of robots in warehouse

The paper heavily relies on exploration of a particular technological solution – integration of robots because both organizations selected for case study – Amazon and Ocado started the trend of robotization. Bogue (2016) explained that the e-commerce sector has experienced a significant growth in the past decade; and the retrieval of e-commerce products are extremely expensive, in particular, human workers picking up the items in warehouses account for 55% of warehousing costs (p. 583). Robots, in turn, can easily substitute people in these monotonous tasks.

The term “robot” stands for a machine that is able to perform human tasks and complex activities by being computer programmed (Löfgren 2016). Robots can change the workplace design and nature of operations dramatically (Berkers et al. 2022: 1855). Mikušová et al. (2017) add that in logistics, the requirements for robots are stricter and more precise – they have to be able to distinguish objects in a wide variety of products, interact with employees and the physical environment (p. 1).

2.2.1 Evolution of robotization in logistics

The evolution of robotization in the logistic sector is the following: 1) In the 19th century transport was invented instead of using animals and people; trains, ships and trucks started being in use for transportation; 2) In 1960s logistic equipment became partially automated for storage and inventory; 3) In 1980s information technologies started being a key element in logistics management; 4) Digitalization of logistics processes in 2000s; 5) Currently, the fifth revolution is developing that will introduce robots with abilities equal to people; they will be integrated in cloud systems to communicate with each other for a better performance (Oran & Cezayirlioglu 2021: 150). Nowadays robots are used for loading and unloading trailers and containers (Mikušová et al. 2017: 3). The same source depicted that the main purpose of adopting robots is to optimize

operating processes as they are able to scan shipments, analyse complex data, move small shelves to warehouse employees, follow workers with objects and pick items by themselves. The further development of robotic application is collaborative workforce that means robots will support human labour and accelerate performance (Oran & Cezayirlioglu 2021: 153). The article by Lambrechts et al. (2021) shows that robots by working together with employees can solve several issues that occur in warehouses: 1) before robotization, human workers were responsible for picking goods and preparing orders; it was really difficult for employers to find motivated employees for such a job, now robots are able to do it fast and non- error; 2) case- and order-picking, in the past workers were case-picking using trolleys and trucks, now they are replaced by robots; 3) unit-load picking for pallets, before it was a work of a group of employees, now it requires less human capital (p. 4).

2.2.2 Benefits of integrating robots

The benefits of adopting robots to the logistics workplace are: 1) their ability to perform repetitive actions with no negative impact on quality; 2) no need for salary or breaks, which in the end results in lower operating costs; 3) improved quality of operations and maximized working capacity (Löfgren 2016). Moreover, in the field of logistics and warehousing, robots lead to lower costs and higher flexibility, and complete several tasks such as order picking, packing, and shipping (Mikušová et al. 2017: 1). In turn, IoT technologies allow businesses to share information about packaging and shipping, thus minimizing errors and waste; blockchain technologies are needed to ensure transparency and traceability of operations (Ali & Phan 2022: 645). According to Roland Berger company's report (2016), robots are six times more efficient than human workers, and 20-40% of cost reduction can be expected by means of robotization (p. 7). Thus, it can offer a faster return on investment and improve profitability of business (Grover & Ashraf 2023: 13). Apart from the mentioned points, robots increase the competitive position of the company (Oran & Cezayirlioglu 2021: 150) as well as the use of technologies can contribute to a

better image of the organization due to the fact that warehouse activities produce a big amount of carbon footprint (Ali & Phan 2022: 645). As a result, customer demands are changing regularly and the world is changing respectively, resulting in innovations that every industry adopts.

2.2.3 Robotics studies in warehouses

In order to emerge in the topic deeper, an intralogistics robotics study of McCrea (2023) was investigated. Her quantitative study in a form of online survey depicted that more organizations are interested in deploying robots in their operations, in particular 43% of the respondents are willing to integrate robots in the next three years, while 37% already have robots in their warehouses, and only 4% said that they have no plans in that scope. Henkes, Smith, Cloetingh, Menzies and Moss (2020) added that before COVID-19 there was a low automation penetration, however, the dynamics was changed with the emerging demands for social distancing and faster delivery of items ordered by customers, which made companies ask third-party organizations to design smart warehouse solutions for them rather than developing it by themselves in order to increase productivity and anticipate the demands of end-consumers (pp. 1-2). The main reasons for not investing in robots for warehousing that the participants of the study of McCrea (2023) named included: issues with personalization of orders, lack of management support and willingness to adopt new technologies and embrace the changes, and space and cost barriers. In addition, the respondents highlighted that the return of investment is an important metric when they are considering investing in this solution. At the moment, companies which took part in the questionnaire either at the stage of gathering information and knowledge about warehouse automation or formulating new vision and mission that they can address with technological advancement. It was indicated that the main implications of robots in warehouses are for truck loading and unloading (37%), packing (37%), picking (33%), order picking (33%) and put-away to storage (33%) (McCrea 2023). Kembro and Norrman (2022) also depicted that big online companies (e.g.,

Alibaba and Amazon) invest in warehouse automation, namely in material-handling technologies, to improve operations (p. 108). Another important point to be discussed is the effect of robotization on work conditions and employees, to which the next section is devoted.

2.3 Effect of robotization on work conditions and employees

By means of warehouse automation, it became possible to delegate a vast number of heavy tasks to the robots and other technologies (Nantee & Sureeyatanapas 2021: 2870). Thus, technological advancement transformed the way humans operate in the warehouse sector (Loske 2022: 303).

2.3.1 Human workers injuries in warehouses

As humans are no longer the main operational power in warehouses, they can focus on logistical tasks and controlling the machines to ensure smooth operations (Nantee & Sureeyatanapas 2021: 2870). The need for this intervention can be justified by a high rate of injuries and exhaustion among employees. According to Maheshwari et al. (2023), the average rate of injuries at work in warehouses in the US in 2019 was 4.8 for every 100 full-time employees, monetary wise it was “84.04 million USD per week, approximately 240,000 dollars per year for each warehouse” (p. 2).

2.3.2 Advantages of warehouse robotization for employees

One of the most important advantages of using robots instead of people is that they can perform hazardous tasks, thus improving health and safety of workers (Löfgren 2016). Furthermore, robots can collaborate with employees, which improves and facilitates operations (Oran & Cezayirlioglu 2021: 148). This collaborative application can be seen in the following areas: 1) one of the new work duties of workers is to control robots performing routine tasks such as handling parts on the line and delivering packages; 2) automated transportation; 3) remote monitoring of telerobots in hazardous locations; 4) interactions

between robots and people for entertaining and learning outcomes (Lambrechts et al. 2021: 3).

Workplace automation leads to reduced need of human labour, but at the same time to improved working conditions and business performance (Löfgren 2016). Particularly in warehouses, robots reduce potential human error, many operations are controlled by computers (Mikušová et al. 2017: 3-4). Referring to the study of Oran and Cezayirlioglu (2021), the past experience of industrial revolutions provides evidence that the use of robots has a positive impact on work productivity (p. 151). Löfgren (2016) postulates that robots take over workers' "easy tasks", leaving more advanced tasks for humans. The article of Lambrechts et al. (2021) confirms this point by saying that robots can be in charge of routine work, while employees can focus on critical objectives and show their expertise (p. 3).

2.3.3 Risk of human workers' substitution

Further evolution of robotization will lead to almost no requirement of human interactions in relation to goods-in and goods-out processes (Ponis & Efthymiou 2020: 14). This might form a controversial point that not everyone is willing to progress at work, learn new and increase their competencies and qualifications (Löfgren 2016). The real industry case is Amazon who changed tasks of line workers from stacking plastic bins to controlling robots (Berkers et al. 2022: 1854). The authors also demonstrate examples when strict supervision of workers who can be replaced by robotic labour led to higher expectations from management that might result in employees' injuries and increased level of stress. As a result, it can be said that people are scared to be substituted by machines, the results of the research show that 29% of logistics employees have this kind of fear (Lambrechts et al. 2021: 4). The study of Loske (2022) presented that overall, 47% of jobs are at risk (p. 305). In addition to the mentioned points, robotization resulted in monotonous tasks for human workers, making employees demotivated and dissatisfied – if before they had to

move, carry items, now robots complete these tasks, and workers only need to pack it in a box. At the same time, old tasks that have been assigned to cohorts, are rarely compensated, meaning that employees have less work. In other words, people are left out with functions that robots are not able to perform (Berkers et al. 2022: 1864).

2.4 Challenges in adopting technologies in the warehouse sector

Disregarding many advantages that automation systems and robots can bring to warehouse operations, managers struggle with accepting and implementing technologies. Grover and Ashraf (2023) declared that companies are afraid of mistakes, limited sources and uncertainties (p. 2). The main challenges include workforce, high investment cost, and lack of resources, that are presented in the next sub-sections.

2.4.1 Workforce

One of the main challenges that businesses operating in logistics, in particular in the warehouse segment, face is related to the changes in requirements for human workers. It demonstrates a potential social conflict – nowadays companies are more interested in hiring talents that have acquired technological skills and capabilities, acknowledged about automation and Internet systems because the modern warehouses have to focus on the development of their workforce while employing robots and other technologies (Nantee & Sureeyatanapas 2021: 2886).

2.4.2 Initial investment

Sahara and Aamer (2021: 626) and Tagashira (2022: 2) pointed out that another barrier is a high cost of investment required to implements robots in warehouse operations, because robots and other automation technologies cannot be standardized (Perotti et al. 2022: 200), but have to be tailored specifically to certain jobs and routes in warehouses (Nantee & Sureeyatanapas

2021: 2869), which means that there is a need for a whole redesign of the warehouse (Perotti et al. 2022: 205). For this reason, the same source proposed that it is better to start to adopt robots step-by-step. Furthermore, to make up the costs, it was suggested that warehouses can inform their target market about the use of warehouse automation technologies via press releases and third-party activities that can help organizations to attract more customers and increase the return of investment (Tagashira 2022: 6).

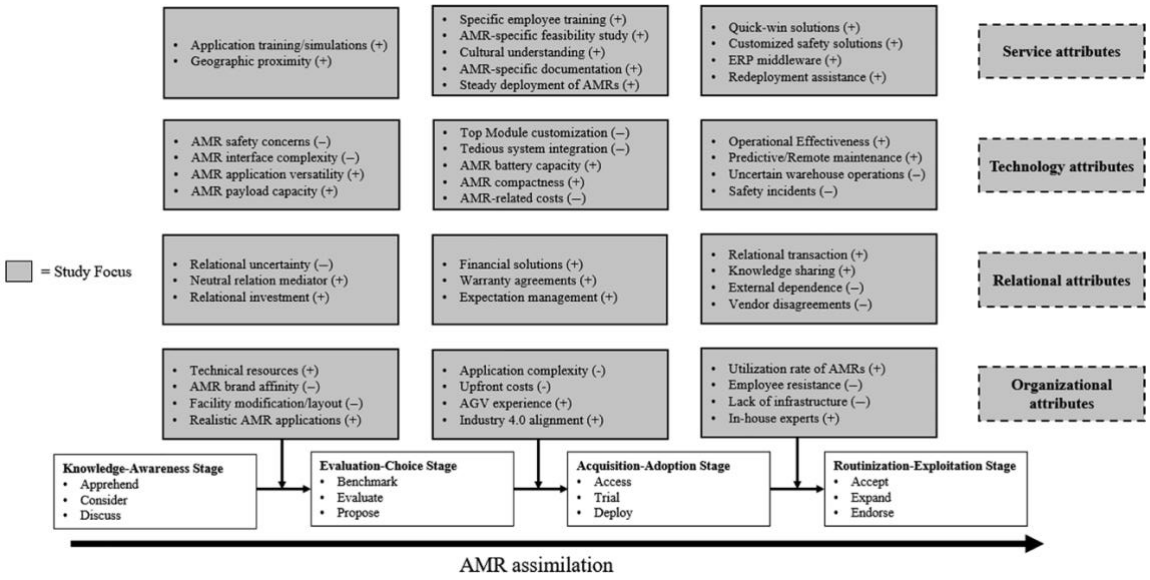
2.4.3 Lack of resources

When warehouse organizations do not understand the reason and benefits of employing technologies in their operations and design, and the “knowledge-awareness” is the first stage of innovation adoption, it does not allow them to visualize the use of technologies in the facility, thus, acts as a barrier (Grover & Ashraf 2023: 5). Another reason is a lack of resources that include infrastructure, specific skills, knowledge, algorithms and technologies (Perotti et al. 2022: 206).

Given all the barriers, companies should focus on long-term advantages that warehouse automation can bring them, collecting information from the relevant industry reports, and integrating robotic solutions from the third-parties that are specialized on it to reduce initial costs. This way, they will be able to gather a competitive advantage and improve overall business performance that would outweigh the risks.

Grover and Ashraf (2023) developed a conceptual model of warehouse automation assimilation that is presented in Table 1 on the next page, where AMR stands for autonomous mobile robots, summing up the benefits and challenges that companies can face (p. 5). From there it can be seen that service, technology, relational and organizational attributes are the main moderates and areas that warehouse companies pay attention to, while considering implementing robots in their facilities.

Table 1 Moderating factors of warehouse automation assimilation (Grover & Ashraf 2023: 5)



Concluding, the thesis empirically assessed the theoretical background on warehouse automation and Logistics 4.0, including its impact on both organizations and employees. The main benefits of the application of robots and other automation system in warehouses are increased of productivity and efficiency, speed and accuracy of delivery, reduced operational costs, improved customer satisfaction and overall business performance, however, on the other hand it raises a risk of human worker substitution and can lead to more stress and injuries at workplace. Apart from that, other challenges include lack of resources and high initial investment. Therefore, the author proposes to overview the real industry examples to assess whether the effect of warehouse automation on the performance of Amazon and Ocado and their human workers. The following chapter presents the methodology of the study, followed by the analysis of the companies, results gathered to find answers to the stated research questions.

3 Methodology

This chapter is devoted to the explanation of methodological choices applied in the thesis, focusing on selected research methods, reviewing how data was collected and analysed, followed by outline of limitations of the current study.

3.1 Research Methods

The research philosophy is a set of beliefs and assumptions that are required to develop knowledge (Saunders, Lewis & Thornhill 2019: 130). Referring to the same source, there are five research philosophies: positivism, interpretivism, critical realism, pragmatism and postmodernism. The study applied interpretivism philosophy, because this research paradigm is suitable for qualitative studies, in which form this thesis was pursued, allowing the author to interpret a wide range of text data (Saunders et al. 2019: 145). This methodological choice is explained by a need to explore social phenomena, investigating the effects of technological advancement on business performance and work conditions of employees in the logistics industry, in particular in the warehouse sector. At the same time, this is a case study, thus, it relied on the direct experience of two companies (Ugwu & Eze 2023: 20), namely Amazon and Ocado. Furthermore, the study first analyzed themes and concepts derived from the previous research, then focused on collecting secondary data from available sources on the warehouse automation in two companies, which in the end resulted in finding new pieces of data that can be conceptualized and further defined and emerged with existing academic background for the contrasting purposes.

3.2 Data Collection

The thesis applied only secondary research, the data for which was collected by researching EBSCO and Emerald academic databases, using keywords “Amazon warehouse automation”, “robotic warehouse study”, “warehouse

automation" and "Ocado warehouse automation" materials in newspapers, academic papers and periodicals. In addition to that, the secondary data was collected by conducting research in search engine, Google, going through various websites and online media to gather required information to fill the literature gaps and expand the existing information on what strategies and tools are currently employed in warehouses. These sources were leveraged for their accessibility and comprehensive coverage. Obtaining information from reputable publications and specialized authoritative websites contributes to the credibility of sources, which minimizes potential bias and errors in the study. Therefore, the author applied a purposive sampling technique that involved the deliberate and purposeful selection of data sources that were the most relevant to the research question. Overall, this sampling method is commonly used in qualitative studies to identify and gather data from information-rich sources for the most use from a limited range of resources (Palinkas, Horwitz, Green, Wisdom, Duan & Hoagwood 2015: 2). At the same time, this approach allowed the author to choose exact reports, online sources and articles that were directly related to the selected case studies – Amazon and Ocado, which were not explored widely in the academic literature. The main benefits of secondary data involved short completion time, facilitated by a high accessibility of the information sources and a wide range of reports and articles conducted by other authors on warehouse automation, and newspapers articles on warehouse automation in Amazon and Ocado, that in the end led to generation of new insights from previous analyses (Perez-Sindin 2017: 4).

3.3 Data Analysis

Once multiple data sources were obtained, the author evaluated its relevance by reviewing it and highlighting elements and concepts that could have been used in the current thesis, afterwards it was composed and contrasted with existing academic information and research questions, whether it is relevant or not. The analytical approach employed in this study was based on content analysis. Content analysis is a systematic and objective method for analyzing

textual and visual information. In this case, it was used to categorize and code the information gathered from secondary data sources (Wilson 2011: 177). The coding process involved identifying recurring themes, patterns, and key findings related to warehouse automation in the context of Amazon and Ocado. By doing so, it allowed the author to identify and compare the key technologies and strategies employed by Amazon and Ocado in the context of warehouse automation as well as to assess the implications of their strategies on the logistics industry. At the same time, the author attempted to compare two organizations not only based on their technologies, but also outcomes throughout the years in regards to the industrial reports and academic sources in general; which was further contrasted with the conceptualized information from the literature review chapter.

3.4 Limitations

The current thesis is limited to the warehouse sector, and was conducted in the case study format, the findings of which cannot be generalized as they implied real results and experience of two organizations – Amazon and Ocado. Nevertheless, it can provide guidelines for warehouse companies who are currently considering investing in robots and automation systems to avoid potential risks and obtain more benefits. On the other hand, the study is limited due to conducting only secondary study, thus, obtaining information from external sources, websites and related studies with inability to validate these findings, not having the “voices from the first people” – employees and managers working in warehouses in the selected companies. In addition to that, no precise information was found on the actual outcomes in terms of financial figures and productivity and efficiency metrics before and after integrating robotic and automated warehouses. Taking into account this limitation, no concrete comparison between the companies was made. Furthermore, a proper comparative analysis might be inaccurate as the literature claimed that each warehouse is individual and caters different customers, products (i.e., different materials, shapes and product types), plus, the selected logistics companies are

from completely different niches, which does not allow the author to align their robotic implications.

4 Analysis of Amazon and Ocado

The introduction of more advanced and mature technologies, and increasing competition, resulted in a wider spread of adoption of warehouse automation in the logistics and retailing industries (Kembro & Norrman 2022: 108). The current chapter is devoted to the exploration of two case studies of Amazon and Ocado to investigate how organizations implement robots and what outcomes they have already achieved. Apart from that, this section conducts a comparative analysis of the organizations, and provides a contrast of the findings with the literature review to discover similarities and dissimilarities between the theorical and practical implications.

4.1 Case of Amazon

Amazon is an e-commerce platform that employs thousands of people, however, heavily relies on technologies and customers' demands (Delfanti 2021a: 39). A new version of fulfilment warehouses is F-Warehouses which serve only online orders, and in this case, Amazon utilizes the same model. By means of that, it was investigated that the company has over 175 of this kind of centres which fulfils up to 0.5 million units per day (Onal et al. 2023: 2).

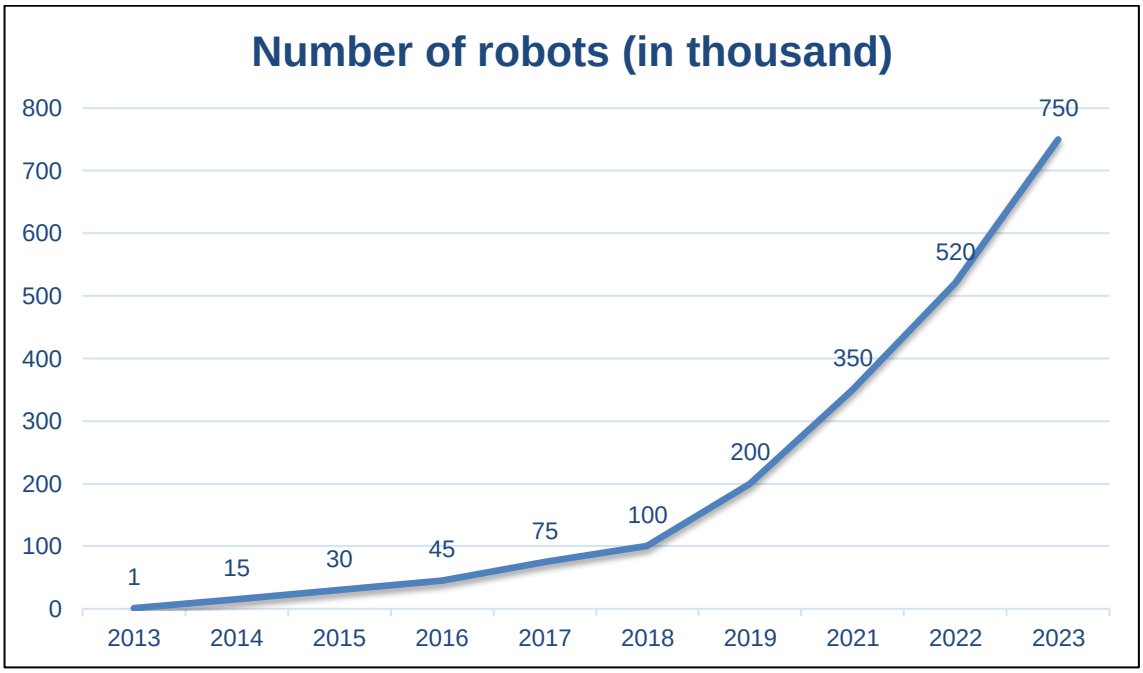
4.1.1 Amazon's robots

Apart from that Amazon started its smart warehousing journey with *Kiva Robots* in 2012 (Kong, Zhong, Xu, & Huang 2017: 1957), the payload of which is 450 kilograms and speed about 5 km/h; then other robots were introduced such as *Hercules* with a capacity of 1500 kilograms; *Pegasus* with a payload of 560 kilograms; *Pegasus X-Sort Drive*; *Xanthus* which is similar to Pegasus but an improved version (own production – Amazon MARS); *Bert* which navigates warehouses with the use of sensors and cameras; *Ernie* moves stacks with its robotic arm; *Cardinal* carries boxes and places them into GoCarts; *Sparrow* is able to handle goods of different shapes and sizes; *Proteus* was also developed

by Amazon itself and can work effectively with human workers; *Scooter* is an automated tractor which “tows empty totes around” and *Kermit* returns empty totes (12 Types of Amazon Warehouse Robots 2022). These robots and detailed description of them are presented in Appendix 1. It is important to note that the intense growth of robotic application in Amazon warehouse and immediate delivery expectations of consumers led to more organizations attempting to develop smarter and cheaper robotic solutions for warehousing that other logistics and warehouse companies can integrate in their operations, which on the other hand, increases the competition in the sector (Del Rey 2019).

The recent robots – Proteus and Cardinal are built to interact with human workers and to reduce the workload of autonomous heavy tasks of individuals, pointing out that it can provide more opportunities for employees to increase their qualification and focus on more complex tasks (Heater 2022). Referring to Koetsier (2022), Amazon had more than 200’000 robots working in logistics, helping to deliver more than 350 million packages. The official Amazon website presented more precise figures for 2023 – 750’000 robots after a decade being involved in warehouse robotization; and only in 2022 a billion of packages, which is 1/8 of all the worldwide orders, was sorted by *Robin*, one of the robotic machine-handling system (Quinlivan 2023). Figure 1 on the next page demonstrates the growth of Amazon’s robotic workforce starting from 2013 until the current moment, except for 2020 as the precise number is missing.

Figure 1 Number of Amazon robots (2013-2023)



Note: The data is from Knight (2023), *Wired*, Copyright 2023 by Wired.

4.1.2 Employees' reaction to warehouse automation

Amazon employed many innovations in logistics, which led to the protests among workers under the slogan "We are not robots" (Delfanti 2021a: 39). The reason for strikes were inhuman conditions, Amazon expected their employees to pick 400 units within the hour, meaning that one item should be proceeded in 7 seconds. Also, the company installed machinery surveillance that records the speed and productivity of the workers, based on which they might get fired if requirements are not met (Sainato 2020). This is an example of the negative perspective of using innovation, not including a human factor and proper breaks as machines are not the same as people. However, it is not solely related to the technological advancement trend, but also to the organizational culture itself. Amazon promotes flexibility, which implies overworking if required just to satisfy the demand, and increase its profitability (Delfanti 2021b: 28). This organization utilizes robots with the aim to improve productivity and ensure that their promise

about the delivery on the next day is fulfilled (Heater 2022). Therefore, warehouse workers are required to synchronize with the operations, disregarding safety and flexibility of work conditions (Delfanti 2012b: 28).

4.1.3 Reasons of Amazon's warehouse automation

The organization highlighted that they use automation technologies not to substitute human workers, but to integrate high tech element for the best of their operations (Quinlivan 2023). It was found that Amazon claimed that they have never had a choice between robots and people, but they emphasize the collaboration of them, which constitutes their vision at the moment (Amazon Staff 2022). The robotic family deployed in the company demonstrates Amazon's determination to cut down on operational costs, ensure safe working environment, anticipate end-consumers' demands and requirements, and contribute to the development of innovative warehouse (12 Types of Amazon Warehouse Robots 2022). Apart from that, the organization stated by combining robots and human workers they are able to deliver better prices, convenience and product selection for customers (Quinlivan 2023).

4.1.4 Impact of automation on Amazon's performance

As the organization supported the on-demand economy, it resulted in an increase of warehouse robotics space by 15% each year, which will lead to the market of value of 23 billion USD by 2027, at the same time improving the productivity of warehouses by 200-300%. The other metrics included a reduced need for walking for humans by 75-80% and doubling or tripling of productivity of the Amazon's warehouses (Koetsier 2022). Del Rey (2019) mentioned that before human pickers had to walk around 10-12 miles a day. The author prepared Table 2 from the mentioned data – comparison of the effect of robotization in Amazon warehouses, presented on the following page.

Table 2 - Performance before vs after robots

Metric	Before robots	With robots
Walking distance of human employees	10-12 miles = average 11 miles/day **Around 18 km/day**	Reduction of a need for walking – 75-80% = average 77,5% 11 - 11 x 0.775 = 2.475 miles = **around 4 km/day**
Average picker's productivity	100 items/hour	300-400 items/hour **Increase by 3-4 times**

Note: The data is from: Koetsier (2022) and Del Rey (2019).

A controversial point would be that disregarding positive elements of warehouse automation is that robots and machines still have to be controlled by humans. Furthermore, in 2019 it was indicated that there were 7.9 serious workplace injuries per 100 workers in robotic warehouses, which is 54% higher in comparison with non-robotic facilities. Also, Amazon's warehouses are more unsafe than other workplaces – 5.9 vs 2.5 cases per 100 employees (Anway 2022). On the other hand, the official website states that the company attempts to develop more technologies that can help to prevent injuries and create a safer environment, removing repetitive tasks and heavy physical actions that were previously assigned to human labour; at the same time, allowing employees to acquire new skills by working with the latest technologies (Quinlivan 2023).

4.2 Case of Ocado

Ocado operates in online grocery deliveries, the organization has one of the most automated warehouses as well as the largest in the world (Ocado Technology 2023). If people associate Amazon with technologies, it is not the case with Ocado, however, it is a technological dark horse (Verdict AI 2019).

4.2.1 Story of Ocado

Ocado has evolved since its foundation in 2000 as both a technological organization and supermarket, employing both hardware and software (Wainewright 2017). In 2012 Ocado started considering how they could improve their operations further, making a decision towards innovation to ensure that their end-consumers receive fast delivery of online groceries, going ahead of the competition and ensuring that the organization can become the dominant company in the market (*Tharsus* 2016). According to the Chief Technology Officer of Ocado, Paul Clarke, the vision of the company from the day one was related to the integration of technologies and automation in order to scale up the business and make the grocery sector sustainable and profitable. In addition to that, their smart platform is tailored for retailers as they cover everything from automated warehouse facilities to ordering and delivery solutions (Verdict AI 2019).

4.2.2 Robots of Ocado

Ocado has a fleet of 3’000 robots in their automated warehouses in London, which start being used right away after the order is placed and received. The examples of such robots can be found as photos in Appendix 2. These robots immediately go to the containers where the required objects are located and begin the fulfilment process. They move approximately five millimetres from each other which demonstrates how smooth and organized codes and algorithms are, allowing Ocado to maximize the efficiency of operations and overall business performance in the end (Davis 2021). Ocado’s fulfilment

centres are designed in a way of having thousands of bots that can pick 50 items in a few minutes (Ocado Technology 2023), which allows the company to deliver 50% of the customer orders within 4 hours in comparison with 10% if no warehouse automation would have been deployed (Bateman 2021). Furthermore, Ocado managed to provide a larger range of products in comparison with a regular supermarket (Wainewright 2017) – Table 3. It can be noticed that by integrating “robotic hives”, Ocado can offer 78.57% more products in comparison to any other conventional supermarket, which can be used to tailor the product line to the demands of different customer segments.

Table 3 - Range of products - regular store vs Ocado

Metric	**Conventional supermarket**	**Ocado – due to automated warehouse**
Range of products	28’000	50’000 = (50’000-28’000)/28’000 = **78,57% more products**

Note: The data is from: Wainewright (2017) and Ocado Technology (2023).

However, Ocado does not only develop robots for their personal use, but they also sell it to other companies, therefore, another focus of the company to create a “living labs” where they could conduct experiments with other organizations to ensure that robots are working well, and can be adopted widely not only in the commerce use, but also in public spaces that contributes to Industry 4.0 (*Harvard Business Review* 2018).

4.2.3 Cost of technological solutions

The smart solutions accounted for 33% of the total revenue of the company in 2019 (Scriven 2020). However, it is important to mention that investors that are interested in Ocado tend to look at the company as a retailer rather than a technological company, which is why the management pointed out that the revenue coming from selling groceries cannot really cover the large set-up costs for warehouse automation (Wainewright 2017).

4.2.4 Ocado's intention to substitute human workers

Ocado developed robots aiming to achieve cheaper and faster deliveries, and solve the problem with the staff shortage in warehouses. Furthermore, the organization stated that it can reduce the labour cost by 30-40% and replace human workers completely one day (Butler 2022; Eley 2022). For instance, this year they are planning to close one of the oldest warehouses, risking 2'300 jobs at once (The Daily Telegraph 2023). The management clarified that instead of this monotonous work, employees can be rotated and assigned to better positions and tasks (Butler 2022). Wainewright (2017) added that the main idea behind integrating robots is to store products effectively and minimize human activities in terms of moving and walking in warehouses.

4.2.5 Accidents due to robotization

The major drawback Ocado has with warehouse automation is fire. It happened already twice due to the robot's battery charging unit failures, which had a negative impact on sales (Global Data Consumer 2021). One of the cases was when three robots crashed into each other, which is why all orders that were presented at that moment, were cancelled (Bateman 2021).

After reviewing both companies, the author prepared a comparative analysis of Amazon and Ocado to see how organizations from different industries integrate

technological solutions, and then contrast it with the theoretical basis prepared for this thesis.

4.3 Comparative analysis

Both niches (e-commerce and grocery) are booming, and taking into consideration the era of technological advancement and changing habits caused by the global pandemic outbreak, warehouse automation solutions resulted in many positive outcomes for the logistics industry. Table 4 summarizes information about both organizations to demonstrate their sizes. Amazon is an American e-commerce giant, Ocado is a British-based online grocery market. The first company is larger in terms of market share and capitalization and generates a significantly more revenue, however, the share price is 3.84 higher in Ocado. Employees are equally satisfied with the work conditions of both businesses.

Table 4 - General information Amazon vs Ocado

Information	**Amazon**	**Ocado**	**Comparison**
Revenue 2022	$ 514 billion	2.5 billion pounds = $ 3.092 billion	= (514-3.092)/3.092 = **165.24 times higher (Amazon)**
Share price 2023	$ 138.6	542.2 pounds = $ 670.72	= (670.72-138.6)/138.6 = **3.84 times higher (Ocado)**
Origin	America	Britain	Different origins, both companies also operate in other countries
Market share	37.8%	5-10% = average 7.5%	= (37.8-7.5)/7.5 = **4.04 times bigger (Amazon)**

Market capitalization	$ 1.43 trillion	4.49 billion pounds = $ 5.555 billion	= (1.43 trillion- 5.555 billion)/ 5.555 billion = **256.43 times bigger (Amazon)**
Employee satisfaction	3.5 out 5	3.5 out 5	Equal

Note: The data is from: Amazon (2024), Ocado Group registers pre-tax loss of £501m for fiscal 2022 (2023), Amazon.com, Inc. (AMZN) (2023), Ocado Group plc (OCDO.L) (2023), Shewale (2023), McKevit (2022).

One of the interesting facts is that both Amazon and Ocado began their warehouse automation journey in 2012, way before COVID-19, opening the prospects for future trends and faster and more convenient delivery of customer orders. At the same time, it could be noticed by the rise of revenue and demand for the products of both organizations. However, the deployment of innovations does not have only positive effects, it also raises a question about the workforce, in particular, what to do with the staff, and how to ensure safety in automated warehouses. Another point would be a common philosophy of organizations, they support customer obsession with fast delivery and are willing to change their work conditions just to satisfy the target market (Delfanti 2021b: 9).

In order to compare the selected organizations, the study reviewed the article of Sword (2019), who said that the Ocado warehouse automation platform is way more advanced than Amazon. It is justified by the speed of robots, Ocado's robots are three times faster than the other company. Furthermore, Amazon's warehouses are less efficient in terms of use of space as during the peak seasons the workload is higher, for instance, for almost the whole year the utilization rate of capacity equals 50%, while during the peak seasons (from October to January) it reaches 90% (Sword 2019). Therefore, it can be stated

that Ocado is more technologically advanced than Amazon, even though their market share is about a hundred times smaller than Amazon (Jagadeesh 2019).

Another interesting point to compare would be the ratio – employees vs robots in Amazon and Ocado, which is presented in Table 5.

Table 5 - Employees vs Robots in Amazon and Ocado

Metric	**Amazon**	**Ocado**
Number of robots in 2023	750’000	3’000
Number of employees in 2023	1’541’000	19’744
Ratio	= 750’000 / 1’541’000 = 49%	= 3’000 / 19’744 = 15%

Note: The data is from: Knight (2023), Davis (2021), Duarte (2023) and Beyrouthy (2023).

From this table it can be seen that Amazon has twice as much robots than human workers, which signals its rapid development in the field of robotic solutions, and can indicate a potential risk of employees’ substitution. Nevertheless, these figures might represent a growing demand for Amazon e-commerce products, which has to be satisfied, thus, the company employs more solutions to remain a high level of customer satisfaction. On the other hand, Ocado aims to decrease the number of human workforces, which means that in the future the ratio can be changed into a higher percentage, while Amazon promotes slightly different strategy – collaboration of humans and robots, which totally differentiates the organizations.

Even though there are many academic sources depicting the topic of technological advancement in logistics, there are no studies conceptualizing the framework of employment of robots and other smart solutions in warehousing, at the same time exploring the theme from the perspective of adopters and conducting a comparative analysis across different niches and countries and investigating the long-term effects of warehouse automation on businesses and workers. Nevertheless, it is required to sum up the results and contrast them with the existing literature that is presented in the consequent section.

4.4 Discussion

4.4.1 Main findings

Warehouse automation is a global trend (Onal et al. 2023: 2), that has been noticed in the case studies of Amazon and Ocado. Furthermore, Amazon was a pioneer in warehouse automation (Bogue 2016: 583), followed by Ocado, which was not surprising as it was a great solution to provide higher business performance – cut down on the costs of labour (Oran & Cezayirlioglu 2021: 152), increase the number of deliveries, be innovative, assist human workers and reduce their physical activity in warehouses to minimize negative impact on their health (Nantee & Sureeyatanapas 2021: 2871), and develop the most effective order picking routes to make warehouses more effective (Onal et al. 2023: 2). Also, by anticipating customers' demands, warehouse robotization incorporated in the organizations' brand images (Ali & Phan 2022: 645) - if Amazon is a huge organization and their actions were highly visible, Ocado had to be a dark horse for a while. It is important to mention that both companies continue to innovate their approaches and robotic solutions, indicating that the industry is going through further development, and other companies should keep up with the trend if they want to stay relevant and competitive in the market, which corresponds to the findings of McCrea (2023).

Löfgren (2016) claimed that by integrating robotics in warehouses, it would lead to decreased number of injuries among human workers because they are no longer in charge of hazardous and dangerous tasks, however, Amazon's results proved it wrong. It was depicted that the number of work accidents only increased, which is controversial, however, it can be explained by the fact that the quota for each employee in regards to the work plan just increased, making them work more. When workers are entitled to produce higher results – if before people had to scan 100 items per hour, now it is around 400 goods, it becomes more stressful (Robitzski 2020), and by not having established policy for working alongside with robots, people make mistakes (Dosu 2018). This demonstrates a thought mentioned in the article of Lambrechts et al. (2021) – these authors stated that the management can increase their expectations, which leads to more frequent incidents at the workplace (p. 3). Amazon keeps on investing in technological solutions rather than in their human workforce (Robitzski 2020), which again does not align with their statement about combining humans and robots for the good of both employees and organization. This opens up a new challenge in the sector of warehouse automation.

On the other hand, the case of Ocado, where the company emphasizes their intention to substitute human workers, supported the studies of Lambrechts et al. (2021: 17) and Loske (2022: 305), who mentioned that logistics employees are at the risk of losing their jobs. The reason behind substituting human workers is understandable – Ocado wants to maximize performance, at the same time minimizing all potential costs that are possible – such as labour. Nevertheless, robots cannot operate independently for 100%, there is still a need for controlling them (Nantee & Sureeyatanapas 2021: 2870).

4.4.2 Answers to the research questions

The thesis addressed several questions to be answered throughout the study, the findings of both literature and case studies now allowed the student to provide comprehensive responses.

The first question was: *How does robotization affect the performance of warehouses?* It was investigated that Amazon and Ocado's experiences of warehouse robotization shows significant enhancements of the warehouse performance in regards to improvements in efficiency, productivity, and delivery speed due to automation. Key performance metrics, such as reducing walking distances for human employees - from almost 18 kilometres to 4 kilometres per day; increasing the number of items processed per hour - the number rose up to 50% in Ocado, and in Amazon by 3-4 times that corresponds to the findings of Roland Berger company's report (2016), which mentioned that the efficiency can be increased by 6 times due to warehouse robotization (p. 6); and optimizing space utilization - robots can pick much more items and their routes are optimized – Ocado's "hives", provide clear evidence of the positive impact of robotization.

The academic literature depicted similar results, in particular, robots are more productive as they do not need breaks and can operate with the minimal potential error, they improve the quality of operations and can provide a higher flexibility, at the same time decreasing the costs of the operations.

The second question was: *How does automation impact the work conditions of warehouse employees?* Overall, the work space is supposed to become a safer place by taking over hazardous work and repetitive tasks, allowing employees to focus on more complex tasks, while the risk of reducing human workforce is present, and the case studies proved it. The case of Amazon highlights the importance of maintaining a human-centric approach as rapid adoption of warehouse automation solutions without considering the human factor can lead to workforce protests. In contrast, the case of Ocado points out safety concerns, particularly related to workplace injuries, resulting from robotization. The experiences of both companies emphasize the need for comprehensive safety protocols to mitigate concerns and create a safer working environment for employees.

The third question was: *What are the strategies and technologies used by Amazon and Ocado in warehouse automation?* Both organizations utilize different robots and invent their own robots for both commercial and personal use. In addition to that, companies do not stop in regards to the development of new technologies, and every couple of years they develop new methods and robots that are more efficient and productive compared to precentors. If Amazon's strategy is based on the concept of corresponding to customers' demands by collaborating human workers and robots, Ocado wants to achieve the same goal by reducing reliance on employees, becoming the most innovative hub.

The last question was: *What are the implications of using robots for the warehouse industry?* The current thesis demonstrated more benefits than risks and drawbacks of the adoption of warehouse automation solutions, companies can return their investments in technologies by delivering more goods and anticipating demands of their customer base. The warehouse industry is currently going through major transformations because more and more organizations deploy various technologies, therefore, there is a strong need for creating new work positions and finding suitable tasks for humans to remain sustainable.

By addressing these research questions, the study has provided valuable insights into the impact of robotization on warehouse performance, employee work conditions, automation strategies, and the broader implications for the industry. The final chapter presented next highlights the main findings and recommendations.

5 Conclusion and Recommendations

The last chapter of the thesis is devoted to the summary of main findings and provision of answers to the stated research questions, on the basis of which the author provided insights for academic world and warehouse organizations.

5.1 Main findings

Based on both academic and industry findings, it can be concluded that warehouse automation and robotization in the logistics industry has a serious impact on the organizational performance and work conditions of employees. Companies use different technologies, aiming to facilitate the workload and increase productivity of their workers and warehouses, at the same time cutting down on expenses and human labour with no consideration and plan what to do with the jobs being under the risk of replacement. Due to the novelty of the matter, workers have to learn and become more qualified to focus on more critical and advanced aspects of work, where they will be able to show their expertise and experience, for which they will be financially rewarded in terms of increased wages. On the other hand, businesses should not be afraid of investing in innovation to keep up with the demands and trends of the market, at the same time not forgetting about the health of employees as robotic solutions might seem to be helping humans and taking over their dangerous tasks – people can still receive injuries due to a higher stress and workload.

By conducting secondary study of the selected companies – Amazon and Ocado, it was found that even though organizations operate in different niches and regions, they have similar outcomes of warehouse automation – robots increase the speed and accuracy of the orders and delivery as well as that it has a positive effect on the profitability of businesses. These cases also revealed that the companies employ diverse strategies in the warehouse automation journeys. While Amazon emphasizes the collaborative role of robots and human workers, Ocado leans towards replacing human workers with

advanced automation as already at the moment robotization of warehouses can decrease labour cost by 30-40%. These variations in approach are aligned with the literature's discussions on the range of options available to companies in adopting warehouse automation, pointing out that the risk of substitution exists as well as the integrative approach of human and robot interactions.

It was revealed that warehouse automation significantly enhances the performance of warehouse operations. Both Amazon and Ocado have reported substantial improvements in efficiency, productivity, and delivery speed. The numbers are compelling, with a 75-80% reduction in the need for human walking in Amazon's warehouses and Ocado's ability to fulfil 50% of customer orders within four hours. The efficiency went up significantly, it became 3-4 times higher.

Despite obtaining positive evidence of adopting robots in the warehouse operations, McCrea (2023) and Grover and Ashraf (2023) named the most common barriers and concerns that stop companies to integrate technological solutions. It includes issues with personalization of orders, workforce changes, lack of resources and management support and willingness to adopt new technologies and embrace the changes, space and cost barriers.

The thesis examined academic literature, industry reports and various online media to be able to answer four research questions and highlight an importance of warehouse automation that has positive implications for the organizational performance and employees, suggesting warehouse businesses adapt to the changing business environment. However, the findings of the paper cannot be generalized due to its case study nature, but the results can bring more prospects for future studies and practitioners, the recommendations for them are presented in the consequent subsection.

5.2 Recommendations

This section provides both theoretical and practical implications and recommendations for the future studies and practitioners.

5.2.1 Future studies

This study contributes to the academic world in several ways. First of all, it addresses the topic of warehouse automation and robotization which is beneficial for both warehouse organizations and companies developing technological solutions for logistics. Secondly, the thesis went through advantages and disadvantages of warehouse automation, combining information collected from various scholars, whereas there was no previous study that incorporated both effects on employees and organizations with an exploration of the real cases – Amazon and Ocado.

Further studies are recommended to conduct primary study, incorporating a mixed method approach to gain a perspective of both warehouse managers and employees through face-to-face interviews and surveys. By doing so, the optimal models for human-robot collaborations can be developed as well as the different strategies employed by companies can be explored, and the long-term impacts on employee satisfaction, productivity, and safety can be assessed and compared. Throughout the thesis, it was found that organizations are mainly focused on their performance with no particular care for their employees, which might lead to protests (as in the case of Amazon), which can further ruin the reputation and brand image of the brand. Therefore, in the next studies, the perspective of workers should be carefully investigated to demonstrate the results to the managers of warehouse organizations, promoting a change in work environments. Apart from that, it is suggested that a comparative analysis of organizations is developed. The analysis could examine companies operating in the same niche, industry and region with relatively the same size to examine what technologies and strategies companies utilize. The reason for it is that the

current study overviewed completely different businesses of different sizes, niches and from different countries' markets which does not allow to generalize results.

5.2.2 Practitioners

Insights on the identified themes such as warehouse automation and the use of robots, including its benefits and challenges of adoption can be found valuable for e-commerce platforms and warehouse organizations who aim to align their business models with the current demand of consumers to ensure fast delivery and high customer service. Furthermore, the findings can be used by warehouse systems providers to see what issues warehouses face to develop a mitigation plan and algorithms that can be tailored to each warehouse and organization as the set-up is strictly individual. Warehouse managers should be educated on the advantages warehouse automation can bring, at the same time preparing themselves and their employees for the human-robot interactions and transforming the jobs that would allow robots to take over heavy physical tasks, leaving more complex for human workers without a risk of substitution. It is important to mention that even if the company wants to manage its warehouse completely by the use of technological solutions, it is not relevant yet as these systems and robots have to be monitored and controlled by humans.

It is recommended for organizations, that are interested in warehouse automation, to invest in technological solutions step-by-step due to a large initial investment required in the beginning. By doing so, they will have more time to measure the progress, educate and train their employees, finding them more suitable tasks. At the same time, the companies should develop enhanced safety measures for robotic warehouses. This could involve investigating safety protocols, assessing robot battery charging units, and reducing fire risks to safeguard both workers and automation systems; alongside with regular assessments and training which are vital components in creating a safe working environment.

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Appendices

Appendix 1 – Amazon robots

Adapted from 12 Types of Amazon Warehouse Robots (2022).

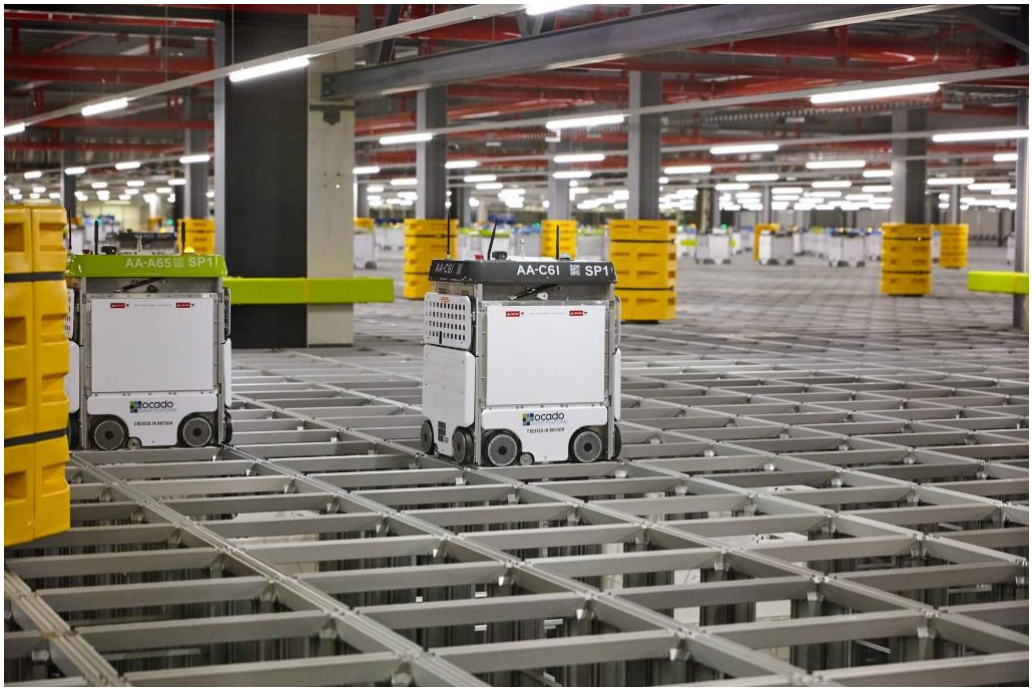
Robot	Picture	Description
Kiva		Goods to Person robot near 75x60x35 cm. Payload 450 kilo grams (1000 pounds). Speed of about 5 km/h.
Hercules		Similar to Kiva but with 3000 lbs lifting capacity (near 1500 kg)
Pegasus		Pegasus replaces the original Kiva but 19 cm thiner. Payload 560 kg
Pegasus X-Sort Drive		Using the Pegasus as the base, different attachments can be added on top. X-Sort Drive, a half-meter belt of conveyor, is an example of such an attachment.

Robot	Picture	Description
Xanthus		Hybrid Robot. Xanthus succeeded Pegasus. In June 2019, Amazon MARS presented this robot for the first time. This drive unit can also carry pods, but it can be used with a variety of attachments.
Bert		Bert is mobile and can navigate the warehouse with the help of cameras and sensors. It can be ordered and programmed to transport packages within a facility by a worker.
Ernie		Ernie moves around the stack using a robotic arm. It lifts totes from the stack to place them in front of workers.
Cardinal		Cardinal is an autonomous workcell able to pick boxes and accurately put them into GoCarts. From here, another AMR like Proteus can move the cart to next destination.

Robot	Picture	Description
Sparrow		Presented in Nov '22, Sparrow is a cutting-edge picking robot able to handle goods with different cur vature and size.
Proteus		The first AMR fully developed by AMAZON able to navigate safely and collaborate with humans.
Scooter		Scooter is an automated tractor th at tows empty totes around, Kem et specializes in returning empty t otes.
Kermit		Kermit is an automated guided ca rt (agc) with magnetic navigation where decision points are tags on the flooor tha indicate if it should c hange direction, speed up or slow down as it travels along.

Appendix 2 – Ocado robots

600 Series bot – is a lighter and more energy-efficient robot, with over half of its parts 3D printed. Also, the hive is presented below.



Robotic hands to pick the products.


ocado
ocado
ocado