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IMPROVEMENT OF WAREHOUSE PROCESSES THROUGH DIGITALIZATION SOLUTIONS

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Abstract

New technologies have transformed various sectors, including warehousing and whole logistics. This article explored warehouse processes without and with digitalization solutions. The aim of this study is to analyses the current challenges faced in traditional warehousing operations and to propose effective digital strategies that could level up warehouse efficiency and overall performance. By analyzing literature review the research examines various digitalization tools, such as warehouse management systems, automation and robotics, internet of things (IoT), optical and radio frequency identification and automation technologies (RFID). Findings indicate that integrating these solutions can lead to more efficient processes, reduce operational cost and improved inventory management. This research leads to a better understanding of how digitalization can revolutionize warehouse operations, also provides how digitalization can affect warehouses processes in future. The purpose of this study is to investigate the impact of digitalization of warehousing processes on organizational efficiency, effectiveness and operational effectiveness. The study aims to identify the benefits and challenges associated with digital solutions in warehousing, providing insight into how these transformations can change productivity and overall company management. Research objectives. To analyze the concept of warehouse processes; to present digitalized warehouse processes; to identify changes in the company to digitalize warehouse processes. Investigation methodology. The study begins with a literature review on warehouse management, process optimization and digitalization technologies. The literature review will focus on analyzing studies, articles, and reports for warehouse management, warehouse process optimization, and the impact of digitalization. The study will involve digital technologies and tools that have been developed to optimize warehouse operations. Conclusion. The digitalization of warehouse processes brings about dramatic changes in the work of companies. Operations have become more efficient. This study has shown that digital technologies such as WMS, automation, robotics, loT and AGV can optimize warehouse management, e.g. order processing, better use of storage space. Innovations reduce the need for human labor, increase accuracy and speed, communication through the supply chain, and customer satisfaction. It is obvious that digitalization processes bring many benefits to companies. Implementing technology into processes is expensive, and training employees takes time and money. Despite the installation process, technology contributes to efficiency, warehouse safety, and the ability to quickly adapt to a changing market. By implementing the latest technologies, companies are able to increase their competitive advantage and reduce operating costs.

Key words: warehouse, digitalization, processes, efficiency, logistics, robotic, technology

Introduction. ***Relevance of the topic.*** Nowadays digitalization is affecting warehouse processes and pushing for new strategies, innovative products and new ways to communicate (Broccardo, Vola, Alshibani, Tiscini, 2024). Competition between companies is very high. Strategic operational goal that companies are pursuing is gaving all the operations of the lowest cost possible, reaching flexibility and reliability (Rossini, Ahmadi, Staudacher, 2024). Efficient product movement, storage and information transfer within the warehouse are crucial for company competitiveness, the most common mistakes that companies make are: expensive handling and use of the storage space; low using of the storage area and space; high cost and outdated equipment; outdated methods of dispatch goods; outdated methods of computerized processes (Kronova, Izakrikova, Trebuna, Pekarcikova, Filo, 2024). For warehouse optimization its recommended to use newest technologies. For sure they are expensive, but not as much as outdated, broken down programs and equipment. Most effective warehouses processes digitalization warehouse management systems (WMS), automation and robotics, internet of things (IoT), mobile applications and tools, cloud technology, streamlined and efficient processes, Artificial Intelligence (AI), optical and radio frequency identification (RFID) technologies, automated guided vehicles (AGVs) (Cai, 2024).

A problematic question. How would the digitalization of warehouse processes affect the company efficiency?

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The aim of the article. The aim of this study is to investigate the impact of digitalization warehouse processes on organizational performance, efficiency and operational effectiveness. The study seeks to identify benefits and challenges associated with digital solutions in warehousing, providing insights into how these transformations can change productivity and overall company management.

Research objectives. To analyse warehouse processes conception; present digitalized warehouse processes; determine the changes in company for digitalizing warehouse processes.

Methodology of investigation. The study begins with a review of literature on warehouse management, processes optimization and digitalization technologies. The literature review will focus on analyzing studies, articles and reports to warehouse management, warehouse process optimization and impact of digitalization. Study will involve digital technologies and tools that been developed to optimize warehouse operations.

4. Definition of warehouse processes

Warehousing is the processes of management and storage of goods which will be picked up, packed and later shipped to the customers. Warehousing is important element in the supply chain. This process ensures that products will reach their destinations on time and in good condition (Team Hopstack, 2023). Warehouse processes include the following steps:

1. Receiving. Receiving step is the first step in the warehouse processes. With this first step is important to ensure that goods arrived in acceptable quality and quantity.

2.Put-away. Second step in processes that includes goods placement in designated areas in the warehouse. Put-away process allows to minimize change of losing or misplace goods

3.Picking. Third process in warehouse is collecting goods. Order picking is the most expensive processes in warehouse operations. This process leads to customers satisfaction, competition and warehouse name.

4. Dispatching. This is the process where goods are sending out of the warehouse. Its important to load orders safely in to the vehicles.

5. Shipping. This is the final steps of warehouse processes. Shipping includes goods movement out of the warehouse to their destination (Sunol, 2024).

The processes is structured and controlled, each warehouse step requires right resources (Batarlienė, Jarašiūnienė, 2024).

5. Digitalization of warehouse processes

The development of new technologies leads to digitalization of logistics business processes. Role of digitalization in source to make logistics company more competitive. World practice shows that most of digitalization processes evolved under quarantine of COVID-19. Most of the people was stuck at home, and this was the best change for logistics companies to optimize and to develop business (Illiashenko, Shypulina, Illiashenko, Golysheva, 2024). Warehouse digitalization involves digital technologies solutions for logistics processes. The development of processes reduces speed in operations and improves security inside warehouse for human forces (Helo, Thai, 2024).

Warehouse management systems (WMS). Management systems are like bridge between company production, scheduling, purchasing and ordering (Suneetha, 2024). Warehouse management systems (WMS) is supporting element to warehouse processes, that makes management easer and efficient. WMS can track stock levels, suggest management strategies and also control the warehouse climate: air ventilation, temperature lighting and other. For successful warehouse management WMS must be integrated into company's information management systems (Kara, Yalcin, Simic, Onden, Edinsel, Bacanin, 2024).

Automation and robotics. Warehouse automation has become a transformative force in logistics. It's reshaping operations and adding more efficiency to warehouse processes and also supply chain. Nowadays one of automation trend is Robotic Process Automation (RPA) (Mattummal, 2024). RPA is software technology that build and manage software robots. Processes automatizes humans' actions with digital systems. Software robots can do things that human can do. But the key is that robots can do it faster and with less mistakes, also they don't need to take brakes. Benefit of RPA: company becomes more profitable, flexible, productive (Dixit, Nargundkar, Suyal, Patil, 2023).

Internet of things (IoT). The internet of things (IoT) is technology that can processes large amount of information with maximum efficiency in real time. This technology can track, trace goods by using radio frequency identification (RFID), sensors, global positioning systems (GPS), laser scanners and other tools. Internet of things works as human-to-machine and machine-to-machine (Umer, Ali, Jehangirl, Bilal, Shuja, 2024). Technology items tracking method is safe processes to deliver or move expensive products, that can be stolen. Top benefits of IoT:

– Innovation. Internet of things gives business access to new opportunities.

– Data turning to actions. Collecting data and past information can predict company from future losses

– Security increases. Products tracking increase safety.

For maximum IoT technology affect companies uses edge computing, cloud computing. Computing edge technology used to make smart devices more useful. That mean computer not only collect or receive data, but also response in time if there is a problem. Cloud technology makes data storage accessible to multiple devices at one time (Jarašiūnienė, Čižiūnienė, Čereška (2023).

Optical and radio frequency identification (RFID) technologies. RFID is a wireless technology used to identify and track objects using radio waves. Technology has two components: RFID tag and RFID reader. RFID tag is small microchip that can store data. RFID reader designed to communicate with tag through radio waves and send tag information directly to computer (Haswika, Qurtubi, Setiawan, Supriyadi, 2024).

RFID tags can carry huge amount of information which can be read by computer in high speed. This future makes RFID technology powerful tool for logistics. Few of main RFID benefits: efficiency, optimization, real-time tracing, inventory tracking and counting, detection of stock discrepancies. This technology mainly is used by manufactory companies, who make expensive products. (Gonzalez, Roca, Bernal, 2024).

Artificial Intelligence (AI). In recent years artificial intelligence (Al) spread around a world very quickly. This technology made warehouses processes revolutionizing and efficient. Warehouses have lost efficiency, because of more complex warehouse operations and an increase need for faster deliveries. Al was the perfect tool for warehouse processes optimizations by computer vision, machine learning and robotic (Sodiya, Umoga, Amoo, Atadoga, 2024). Al collect various type of data, for example sales data. With this function Al can predict when goods arriving and leaving warehouse also can prepare goods in advance using algorithms. Al also can control warehouse machines: robots, automatic forklifts and other transportation equipment. Working with logistics management systems Al can contact suppliers and customers by processing real-time information (Ting, Hang, 2024).

Automated guided vehicles (AGVs). Automated electric technologies have been used in warehouses to reduce productivity and efficiency. Automated guided vehicles (AGVs) actively used in various industries to reduce operations efficiency. Mobile robots designed to transport objects without human interaction.

AGVs are mobile robots controlled by computers. In the technical context advantages of using AGVs that system can easily connect with other technologies such as GPS, RFID and other technologies used in warehouses. On social context AVGs can be used for 24-hour till battery power is low (Wang, Yi, Zhen, 2024).

AGVs works based on sensors, software and guidance systems. Most important robots working principles:

− Sensors. AGVs has laser, ultrasonic sensors, cameras. These parts help robot to avoid obstacles and see surroundings.

− Navigation. AGVs has few methods of navigation. Robots can use laser-guided navigations, magnetic tape guidance, lasers navigations.

− Control system. Central computer system controls AGVs. Computer can control real-time decisions about speed, directions and routes.

− Task and Objectives. Central computer systems indicate instructions and information directly to robots. AGVs can perform specific task: transporting objects between stations, deliver products to designed areas.

Fig. 1. RFID technology (Vaniotis, 2018)

Fig. 2. AGVs robots (https://storage-solutions.com/what-is-an-agv/)

– Safe Features. Robots work safely with humans in the same area. AGVs have emergency stop buttons and avoiding systems (Vlachos, Pascazzi, Ntotis, Spanaki, Despoudi, Respoussis, 2022).

2. Digitalizing warehouse processes

Logistics sector is transforming through digitalization. Better access to information, real-time data collection, improved management and efficiency boosted warehouses to install digital technologies (Ruiz, Martinez, Juarez, 2024).

Installing digital technologies to warehouse affect whole supply chain. Advantages of innovations includes fast decision making, cost reduction and customer satisfaction. Digital technologies also give ability to adopt in changing markets. Digital technologies can be classified according warehouses productivity level. Level have three categories: low, medium, high. Low productivity digital technologies basic systems with limited options. Medium productivity digital technologies can collect and analysis certain data, make decision based on collected data. For high productivity digital technologies can analyze and optimize logistics operations. It can be data collection, tracking systems and others considering warehouse operations (Burinskienė, Daškevič, 2024).

Lots of companies are seeking to automatize operation processes as much as they could. It reduces human work force needs and increases efficiency in processes. In recent years digitalization became very popular due few huge benefits:

– Increased efficiency. By using robots, AGVs, Al, GPS, RFID and other technologies warehouses reduce human force need and improves speed and accuracy. Digital warehouses decrease human errors in management process: order processing, shipping.

– Reduced human force needs. Digital technologies are capable of inventory counting, order processing these jobs usually performed by human. Technologies takes basic jobs, which don't need human intervention. Meanwhile human could concentrate on more complex tasks, like customer services or real-time problem solving.

– Real-time stock level. Digital warehouses give managers clear view of inventory levels, order progress, shipping details. This makes easer for managers to sport and fix problems right away. Stock level information can be shared with all company departments. That ensures fast communication between every part of supply chain.

– Improved order process. It works on speeding up order processes: receiving order, picking order, sending order. Digital technologies do job faster that a human, due faster warehouse processes customers satisfaction rises. Technologies also gives updates to customers.

– Utilization of storage space. Digital technologies use data analysis to maximize storage efficiency. That help companies to reduce extra storages facilities and save costs.

– Improved safety. Lots of warehouses processes can cause injuries and workplace accidents. Automating hazardous tasks by digital technologies can improve safety to warehouse workers.

– Adaptation to market. Digital warehouses can analyze current market trends very fast. That leads

to order point increases or decreases, according situation in market. Digital warehouses revolutionize traditional warehouses operations. With technologies companies can reduce human force needs, improve safety, speed up order processes, increase customer satisfaction and stay competitive in fast changing market (Singh, Singh, 2024).

Conclusion. Digitalization in warehouses processes brings dramatic changes in companies' operations. Performances became more efficient. This study shown, that digital technologies such as WMS, automation, robotics, loT and AGVs can optimize warehouses management, such as order processing, better storage area use. Innovation reduces human force needs, increases accuracy and speed, communication through supply chain and customer satisfaction. Digitalization processes obviously brings lots of benefits to companies. Technologies installing to processes has high cost, also training for employees requires time and money. Despite installing process, technologies bring benefits to warehouse efficiency, safety and ability to adopt to changing market quickly. Adopting newer technologies, companies are able to increase their competitive advantages and decrease operation cost.

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ВДОСКОНАЛЕННЯ СКЛАДСЬКИХ ПРОЦЕСІВ ЗА ДОПОМОГОЮ РІШЕНЬ З ДІДЖИТАЛІЗАЦІЇ

Анотація

Актуальність теми. Сьогодні цифровізація впливає на складські процеси та підштовхує до впровадження нових стратегій, інноваційних продуктів та нових способів комунікації (Broccardo, Vola, Alshibani, Tiscini, 2024). Конкуренція між компаніями дуже висока. Стратегічна операційна мета, яку переслідують компанії, полягає в тому, щоб забезпечити всі операції з мінімально можливими витратами, досягнувши гнучкості та надійності (Rossini, Ahmadi, Staudacher, 2024). Ефективне переміщення продукції, зберігання та передача інформації в межах складу мають вирішальне значення для конкурентоспроможності компанії, найпоширенішими помилками компаній є: дорога обробка та використання складських площ; низьке використання площі та простору для зберігання; висока вартість та застаріле обладнання; застарілі способи відправки вантажів; Застарілі методи комп'ютеризованих процесів (Kronova, Izakrikova, Trebuna, Pekarcikova, Filo, 2024). Для оптимізації складу рекомендується використовувати новітні технології. Звичайно, вони дорогі, але не так сильні, як застарілі, зламані програми та обладнання. Найбільш ефективні складські процеси діджиталізація систем управління складом (WMS), автоматизації та робототехніки, інтернету речей (IoT), мобільних додатків та інструментів, хмарних технологій, налагоджених та ефективних процесів, Технології штучного інтелекту (AI), оптичної та радіочастотної ідентифікації (RFID), автоматизованих керованих транспортних засобів (AGV) (Cai, 2024). **Проблемне питання**. Як діджиталізація складських процесів вплине на ефективність компанії?Метою даного дослідження є дослідження впливу цифровізації складських процесів на організаційну ефективність, ефективність та операційну результативність. Дослідження спрямоване на виявлення переваг і проблем, пов'язаних із цифровими рішеннями в складському господарстві, надаючи уявлення про те, як ці перетворення можуть змінити продуктивність і загальне управління компанією. **Завдання дослідження**. Проаналізувати концепцію складських процесів; представити діджиталізовані складські процеси; визначити зміни в компанії для діджиталізації складських процесів. **Методологія розслідування.** Дослідження починається з огляду літератури з питань управління складом, оптимізації процесів та технологій цифровізації. Огляд літератури буде зосереджений на аналізі досліджень, статей та звітів для управління складом, оптимізації складських процесів та впливі цифровізації. У дослідженні будуть задіяні цифрові технології та інструменти, які були розроблені для оптимізації складських операцій. **Висновок.** Діджиталізація складських процесів приносить кардинальні зміни в роботу компаній. Виступи стали більш ефективними. Це дослідження показало, що цифрові

технології, такі як WMS, автоматизація, робототехніка, loT та AGV можуть оптимізувати управління складами, Наприклад, обробку замовлень, краще використовувати місце зберігання. Інновації зменшують потреби в людській робочій силі, підвищують точність і швидкість, комунікацію через ланцюжок поставок і задоволеність клієнтів. Очевидно, що процеси діджиталізації приносять компаніям багато користі. Впровадження технологій в процеси має високу вартість, до того ж навчання співробітників вимагає часу і грошей. Незважаючи на процес встановлення, технології сприяють ефективності, безпеці складу та здатності швидко адаптуватися до мінливого ринку. Впроваджуючи новітні технології, компанії отримують можливість збільшити свої конкурентні переваги та знизити експлуатаційні витрати.

Key words: warehouse, digitalization, processes, efficiency, logistics, robotic, technology.

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