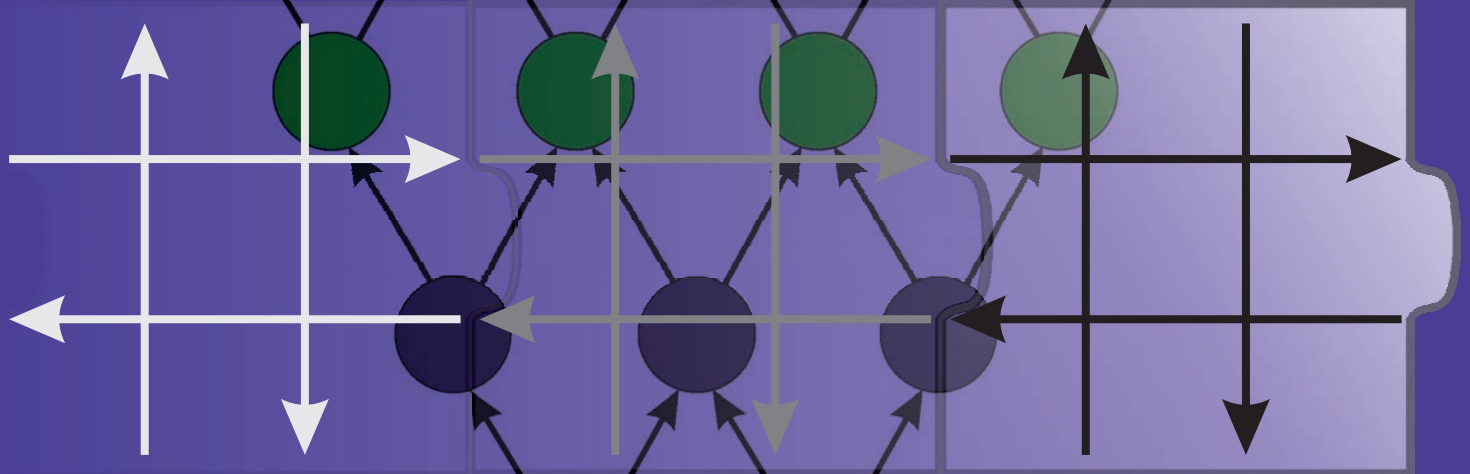
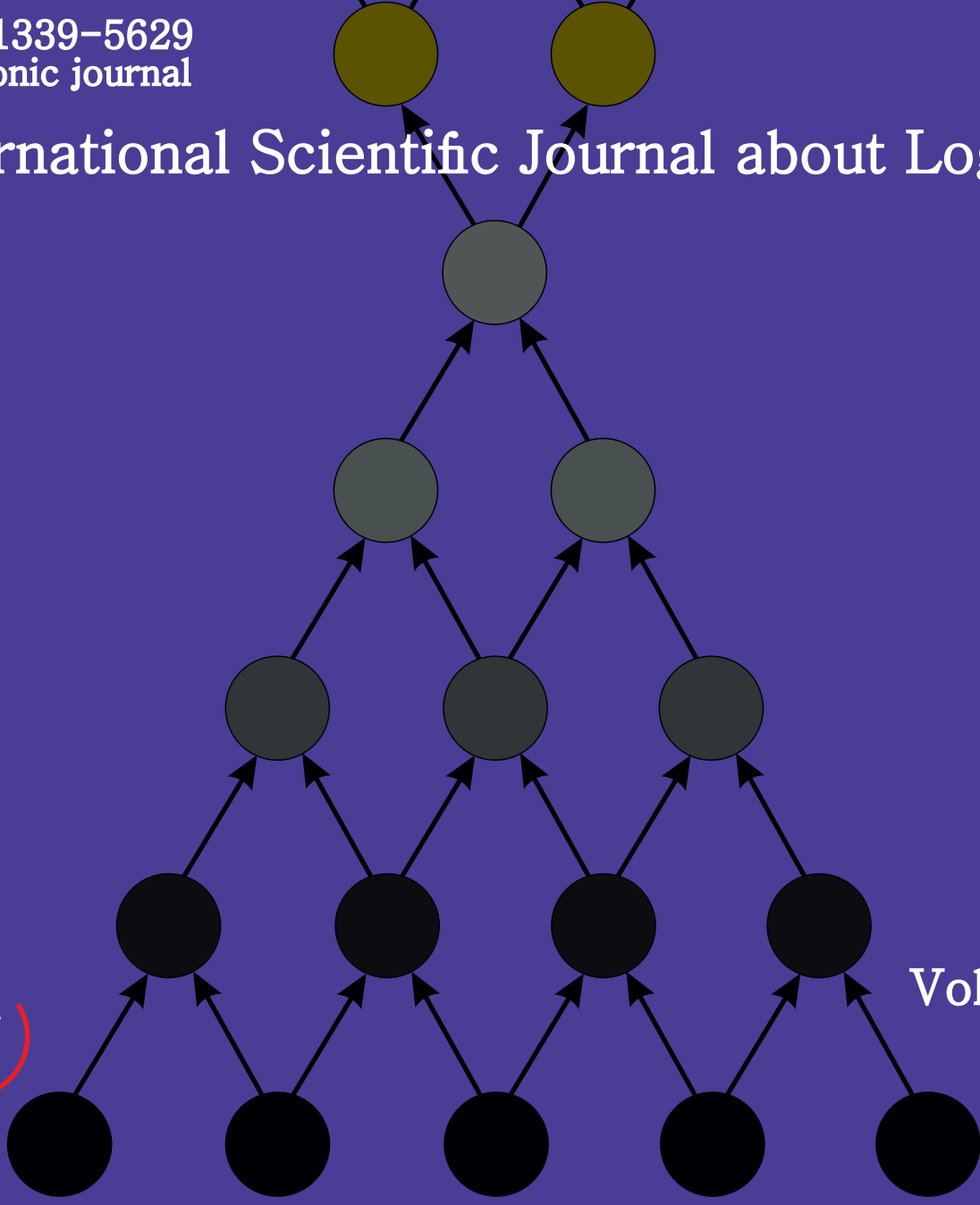


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A review on the positive implications of augmented reality pick-by-vision in warehouse management systems

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Keywords: augmented reality, order picking, pick-by-vision, warehouse management system.

Abstract: Augmented reality (AR) is a significant Fourth Industrial Revolution (IR4.0) technology that employs computer-generated display, sound, text, and effects to enhance the user's real-world experience via wearable devices. Order picking processes have had a substantial influence on overall operational efficiency in warehouse management systems (WMS). The conventional picking process is challenging to handle, which may result in deviations from the intended picking performance. Pick-by-vision, a new technological solution for order picking, is receiving growing attention and is now considered a significant WMS-supporting technology. This article explores the positive implications and prospects of utilizing AR pick-by-vision technology in the warehouse picking processes by performing a narrative review of the previous review articles. To demonstrate the focus of the main area, this study also presents the hierarchical classification structure of AR implementation in WMS and highlights the pick-by-vision method. The analysis provided important key findings by evaluating 23 articles (original articles and case studies) on AR pick-by-vision technology applications, which are significant to the prospective advantages of AR pick-by-vision deployment in warehouse operations. This study gathers knowledge and insight that can be used by both academics and professionals who are interested in optimizing this new advanced technology for future research.

1 Introduction

Since the emergence of the IR4.0, augmented reality (AR) has become one of the most prominent technologies in manufacturing and logistical operations. In a warehouse management system (WMS), AR can be implemented in fundamental processes including receiving, storing, inventory, order picking, shipping, and quality control to enhance warehousing operations, value-added services, and transportation. This technology improves the real-world experience of users by using computer-generated display, sound, text, and effects to help workers do regular tasks like order picking, assembly, and maintenance [1-3].

Order picking is the process of finding a specific item in storage based on a list, loading the items onto the right transportation, and delivering them to the place where the follow-up process will take place. Considered as the main and most labour-intensive task of warehouses, order picking is an important part of prompt assembly line production and is accomplished in many manufacturing industries [4]. Piece picking, cluster picking, zone picking, and wave picking are the four types of order picking [5-10].

Manual order picking is recognized as the most labor-intensive function in nearly every warehouse due to its simplicity and low cost. Manual order picking is instinctual for humans and is normally implemented on paper.

However, the repetitive picking procedure, like reading and checking, consumes time and increases error rates owing to human error.

Enhancing order picking can be costly. For efficient picking process optimization, WMS administrators must match the suitable picking and automation techniques. Fortunately, the use of AR in WMS has lately been more noticeable in terms of enhancing order selection. This technology boosts WMS productivity by allowing for interactive 3D visualization, quick object tracking, inventory management, and automation [11].

To address the significance of AR in the order picking process to streamline the whole process of WMS, a summary of seven review articles is presented according to the ascending years of publication. The earliest review paper by De Koster et al. (2007) presented a detailed review of typical decision problems in the design and control of manual order picking processes. They focused on the optimal (internal) layout design, storage assignment methods, routing methods, order batching, and zoning. In their findings, picker-to-part systems (order pickers walk or drive along the aisles to pick items) have received less research attention compared to parts-to-picker systems [12]. Nonetheless, the study was still lacking in general design procedures and global optimization in order picking and neglected the effect of storage assignment.

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A decade later, Haase & Beimborn (2017) reported the findings from a review study of 17 publications on pickers' acceptance of order picking support systems (OPSS). They discovered seven barriers to OPSS adoption, which comprise an overwhelmingly high subjective task load, loss of autonomy, loss of social interaction, negative influences from co-workers, high complexity in handling the technology, a lack of training, and a lack of maturity of the technology. OPSS provides significant value in terms of performance improvements. However, social effects among employees and different supporting situations must be considered when deploying such solutions and expecting warehouse workers to use OPSS. The limitation of this study is that OPSS adoption seems to be quite isolated so far. The suggestion is to integrate the technology with findings from related research fields in the future [13].

In 2020, Ilanković et al. performed a narrative review to describe the expected benefits and barriers of AR in warehouse operations. They also presented results based on the effect of information availability on order picking time. The study not only demonstrated the benefits of this picking method, but it also highlighted common issues that arise during order picking operations using AR technology, particularly one involving pickers' comfort [14]. However, this study has a limited review of selected studies, which do not comprehensively represent the exploration of recent knowledge about the usage of AR in the picking method and pickers' comfortability for pick-by-vision.

Egger & Masood (2020) conducted a thorough review to identify the current status, current challenges, and future directions of manufacturing related to AR and mixed reality (MR) research. They concentrated on shop floor management rather than picking processes, but the extracted items from the systematic literature review and citation network analysis are regarded as important views in AR in WMS perspective [15].

A recent study by Rejeb et al. (2021) provided a comprehensive review of the potential and challenges of AR smart glasses in logistics and supply chain management. They have selected 82 publications and performed a systematic literature review with four main clusters of potential benefits, including visualization, interaction, user convenience, and navigation [11]. The limitation that can be addressed in this study is that the keywords chosen appear to be insufficiently relevant to the publications chosen.

Another recent study by Winkelhaus et al. 2021 presented a conceptual design of order picking corresponding to IR4.0, which they called OP 4.0. Concurrently, they performed a systematic review to identify the various possible concepts in OP 4.0 and highlighted research opportunities within OP 4.0 at the intersection of social and technical aspects. Barriers found in this study include the research methodology, which relies on subjective decisions and does not apply a quantitative measurement. However, they had a strong

opinion about defending the barriers. They believe that a qualitative, content-sensitive approach is necessary to extract the interactions of parameters instead of extracting the discussed topics solely [16].

The most current study by Rahman et al. (2022) provided a comprehensive review of AR technology in digital manufacturing applications. They investigated mixed reality image recognition, explored mixed reality object recognition, and demonstrated assembly and disassembly of 3D virtual models using Microsoft HoloLens [17]. Their broad ideas in reviewing AR in a digital manufacturing context give valuable information on potential benefits and implications for future enhancement.

In conclusion, the gaps in existing review studies can be summarized into two key points. The first is that order picking has been the main area of focus and diligent attention in WMS, as it will enhance the entire operation's efficiency. The second is the need for keyword search clarity, as well as particularized documents in performing the review study. Overall, there is still a room for improvement in producing a comprehensive review that studies the state-of-the-art literature, discovers the missing potential benefits, investigates the challenges, and discusses the possible trends of order picking using AR in WMS. Therefore, to close the research gap, we pose the following research questions:

- What are the key findings concerning the prospective advantages of pick-by-vision in WMS?
- What positive implications have been overlooked in the literature?

To address these concerns, this paper will highlight recent works that have used AR in WMS, specifically pick-by-vision technology, which will be discussed in more detail in the next section.

The anticipated outcomes from this review are to give useful insights into the gist of the previous proposed methods, revealing potential, and future potential to provide a knowledge base overview of the technology for researchers and practitioners. The objectives of this paper are as follows:

1. To conduct a comprehensive review by identifying the positive implications of AR pick-by-vision implementation for WMS in related studies.
2. To discuss the key findings of prospective advantages and the missing ones based on the review findings.

The remainder of this paper is organized as follows. Section 2 presents a brief overview of the principle of pick-by-vision in warehouse picking operations. Section 3 outlines the methodology for performing the review study and presents the hierarchical classification structure of AR implementation in WMS. Next, we identify important key findings with positive implications by evaluating 23

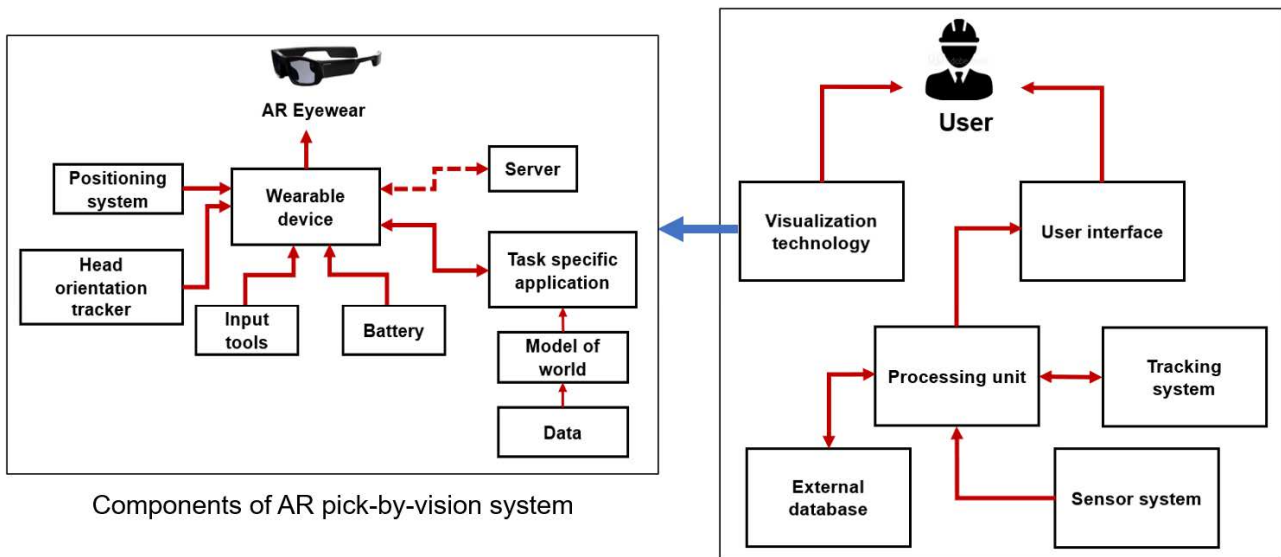
articles on AR pick-by-vision technology applications in section 4. Then, we discuss the findings from the literature survey in section 5, which also reveals the missing key findings. Finally, the last section gives a conclusion and future work suggestions.

2 Overview of AR pick-by-vision

Pick-by-vision of AR is the visual aid of the order picking process using head-mounted displays or smart glasses. It is a paperless picking operation that requires processing orders with technologies that add visual layers to the reality perceived via them. Significantly, pick-by-vision has introduced an entirely new approach to managing warehouses with AR, allowing many organizations to simplify their accuracy and efficiency

levels [18]. The process entails the preparation and processing of input data, the suggestion of an optimal picking route, the proposal of an AR navigation system, the selection of software and hardware resources, the incorporation of picking routes into process maps, and the actualization of the picking process [19].

Figure 1 depicts the interrelationship of the AR general system and the components of the AR pick-by-vision system. The fundamental parts of an AR system are the visualization technology, a sensor system, a tracking system, a processing unit, and the user interface [15]. On the left of Figure 1, represents the system diagram of components for AR pick-by-vision from the projection of visualization technology, which consists of the integrating module for the wearable device [20].



Components of AR pick-by-vision system

General AR system with interaction of each part

Figure 1 System diagram for general AR system and components of AR pick-by-vision system (based on [15,19])

To complete a pick-by-vision operation, a user or picker's operator must communicate by voice, sight, or gesture. Using virtual arrows, the AR device guides the user to the location of the things to be collected and subsequently displays the number of objects to be collected. The user can see virtual information about the items, such as their names, numbers, and locations. This operation will allow the user to quickly locate the products and accomplish the picking task. Once the operation was done, the AR system administrator would monitor operational management, order management, and commodity management of the warehouse.

Figure 2 shows the hierarchical classification structure of AR implementation in WMS and the highlighted pick-by-vision method to demonstrate the main area of this study. From the figure, there are five main types of AR

technology in warehouse operations that encompass receiving, storing, order picking, shipping, and inventory [1,21].

In Figure 2, the picking orders can be categorized into seven types of picking techniques, including pick-by-paper, pick-by-light, pick-by-vision, pick-by-voice, pick-by-gesture, pick-by-scan, and cart-mounted display [7,22,23]. This study focuses on pick-by-vision where the terms for devices' names appear in the literature are head-mounted display (HMD) [24], head-worn display (HWD) [25], heads-up-display (HUD) [22,26], and smart glasses [22,27]. Among the most popular models in the market are Golden-i by Motorola, Hololens by Microsoft, HD4000 by Zebra, Vuzix Blade, and Oculus Quest 2, as shown at the bottom right of the figure. An example of a Hololens application in a warehouse is given in the bottom left [28].

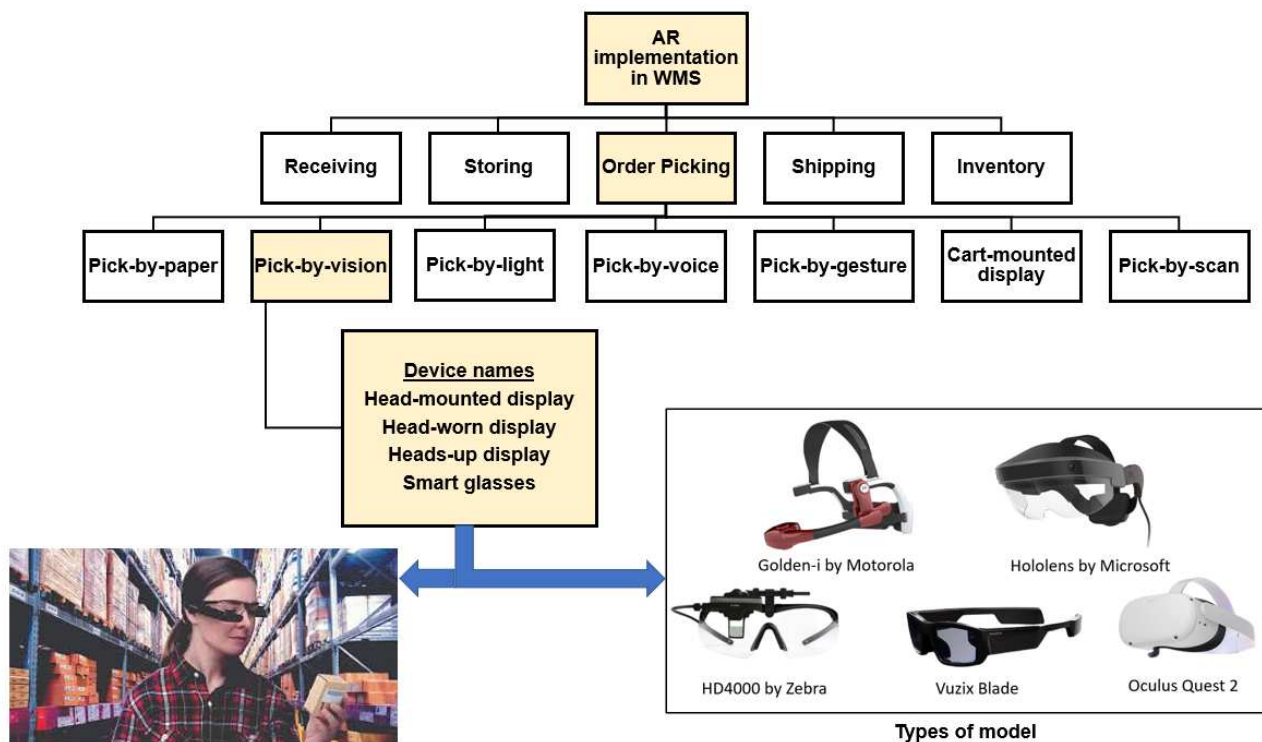


Figure 2 The hierarchical classification structure of AR implementation in WMS with highlighted pick-by-vision methods and application

3 Methodology

This section concentrates on reviewing the use of AR pick-by-vision technology in previous research in WMS. The snowballing technique (by tracking down references or citations in documents) and the use of scientific search engines (IEEE Xplore, Scopus, Science Direct, and Google Scholar) were used in the collection of related material from 2011-2021. Principal keywords in the list of the related works search include "augmented reality," "warehouse management system," "order picking," and "pick-by-vision". We retained 23 papers (17 research articles and 6 case studies) for full-text review after screening the titles and abstracts for relevance.

Based on the survey of previous review studies, seven positive implications which are associated with prospective advantages are discovered: productivity and operational efficiency; error reduction; hardware and software upgrades; distance reduction; worker motivation and training; security and operation planning; and ergonomic consideration. Table 1 represents the prospective advantages of AR pick-by-vision implementation in WMS from the selection of related studies.

In Table 1, the list is arranged in ascending order of the publication year. The author's name and year, target applications, and types of system or devices used are listed

in columns 1-3. The next column lists the major findings of this study, which consists of seven implications items of prospective advantages for AR pick-by-vision implementation in WMS. These items are briefly discussed in the next sections.

4 Positive implications of AR pick-by-vision implementation in WMS

4.1 Productivity and operational efficiency

Order picking is one of the most costly operations since it might be challenging to get the appropriate products from the right section and in the right quantity. These challenges may be solved by using AR technology integrated with mobile devices to guide the worker through the picking process and lead them to the correct picking areas in the shortest possible duration of time. This eventually leads to higher productivity.

With automated capabilities that handle the processes, AR tools improve operational efficiency by enabling workers to work on many orders at once. The improved accuracy and effectiveness of warehouse operations lowers all additional expenses related to finding, picking orders, and tracking, saving a significant number of labour hours and corporate resources. Moreover, customers may anticipate their supplies to arrive substantially earlier and with less asset downtime as a consequence [1].

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Table 1 Selected of relevant studies for AR pick-by-vision implementation in WMS

Authors, year	Target application	Proposed system	Prospective advantages of AR pick-by-vision implementation in WMS						
			Productivity & operational efficiency	Error reduction	Hardware/software improvement	Distance reduction	Worker's motivation & training	Security & operation planning	Ergonomic consideration
Schwerdtfeger et al. 2011 [24]	Navigation and grasping aid.	HMD		✓					✓
Gharbi et al. 2014 [26]	Multi-agent system and optimization.	HUD & AR glasses	✓			✓			✓
Guo et al. 2014 [22]	Comparing the speed, accuracy, error types, workload, and preference.	HUD compared with CMD, pick-by-light, pick-by-paper	✓	✓					✓
Funk et al. 2015 [29]	Performing In-Situ projection for storage management and automatic detection	mobile camera-projector cart (OrderPickAR)	✓	✓		✓	✓		✓
Wu et al. 2015 [30]	Performing comparison to minimize error.	HUD compared with pick-by-light	✓	✓					
Diete et al. 2016 [31]	Sensor reability in picking process.	AR glasses and wristband	✓		✓				✓
Sand et al. 2016 [32]	Supporting assembly workers in picking information and assembly data.	smARt.Assembly and AR glasses	✓	✓					✓
Hanson et al. 2017 [33]	Kit preparation for mixed-model assembly.	HMD compared with pick-by-paper	✓	✓					✓
Murauer et al. 2018 [34]	Evaluating scan mechanisms.	AR glasses and scan glove	✓	✓					✓
Puljiz et al. 2018 [23]	Implementation in autonomous warehouse (navigation, assistance for picking and robot repair).	AR glasses and robot	✓					✓	✓
Bräuer & Mazarakis 2019 [35]	Investigating the effects of gamification in WMS.	AR glasses	✓				✓		✓
Elbert & Sarnow 2019 [36]	Cognitive ergonomics.	AR glasses and qualitative assessment							✓
Fang et al. 2019 [37]	Developing a scalable and long-term mobile AR solution.	AR glasses and marker-based global map	✓			✓			
Kim et al. 2019 [25]	Evaluating performance in simulated warehouse job.	HWD and User Interface design	✓	✓					✓
Krajcovic et al. 2019 [19]	Optimizing the movement of workers in the warehouse.	AR glasses	✓	✓		✓			
Matsumo et al. 2019 [38]	Investigating practical barriers.	HMD	✓			✓			
Nagda et al. 2019 [39]	Focusing on low-level machine-aided order picking.	HMD & web-based central (RASPICK)	✓						✓
Papcun et al. 2019 [40]	Possibilities of using AR and Humans-Robots Interaction.	AR glasses, AGV & Drone				✓		✓	
Fang & An 2020 [41]	Establishing adaptability and scalable wearable AR assistance system.	AR glasses and marker-based global map	✓	✓					✓
Plakas et al. 2020 [2]	Enhancing working environment and upgrading the work experience.	AR glasses & SMARTFLEX	✓					✓	
Plakas et al. 2020 [42]	Assessing the technical components and the overall viability	AR glasses & gamification module	✓					✓	✓
Colabella et al. 2021 [43]	Reviewing current case studies regarding the use of AR technology in supply chain operations.	HMD	✓	✓					✓
Tang & Liu 2021 [44]	Focusing on based interaction, voice-based interaction and gesture-based interaction.	AR glasses (Hololens 2)	✓					✓	

4.2 Error reduction

The conventional picking process is error-prone. AR implementation helps in guiding the worker through the warehouse to the desired item. Rework is eliminated by lowering the error rate. This enhances procedures by reducing turnaround time and increasing system accuracy. Additionally, automation completely automates item tracking while maintaining relevancy and accuracy based on real-time inventory data inputs, enhancing visibility and quality control of warehouse operations [1].

4.3 Hardware or software improvement

AR has a logical as well as a physical structure. The logical structure of the AR, which contains standards, rules, procedures, and protocols, describes its operation, whereas the physical structure comprises hardware and software [45]. The system complexity (like software applications), the weight of the devices, speeding up the processor's timing, and improving the picking system in recognising and monitoring activities (such as grasping and releasing of objects), are all aspects that can improve the hardware and software in AR pick-by-vision. Another element to consider is improving visual navigational information and vision quality on AR glasses [31].

4.4 Distance reduction

One of the major purposes of AR in the picking process is to navigate the workers around the warehouse so they may take the quickest path determined in the previous stage and to provide them with the necessary information to decrease picking errors. Additionally, reducing the amount of time to retrieve an item may be accomplished by presenting the precise location of the chosen collected items and improving the visual information by employing an efficient routing method. As a result, this will save time and improve the way the WMS works in the long run [19, 46].

4.5 Workers motivation and training

Aside from training new employees with less effort and saving time, warehouse managers may adopt AR to visually test proposed procedures, ensuring that companies are flexible and plan order placement with optimal space utilization. By familiarizing them with company processes, this will help in seamless onboarding and improve team cooperation. As a consequence, they may practice numerous times without disrupting or interfering with existing activities. Furthermore, workers may be supervised to raise their awareness and prevent mistakes in warehouse operations [2, 11].

4.6 Security and operation planning

For any organization to succeed, warehouse operations must be structured to achieve maximum efficiency. Standard warehouse operations require product inspection, allocation, assembling, packaging, and dispatching, as well

as designing and testing the viability of a comprehensive warehousing strategy. By using AR technology, warehouse managers can now plan and test the WMS in an effective way. Besides being hands-free and safe for a human operator, AR also provides value-added services such as sharing insights and monitoring all activities to ensure precise service delivery. On top of that, the system may give safety feedback and information, as well as warn of impending danger [1].

4.7 Ergonomic consideration

The ergonomic design of AR technology is related to the perception of its ease of use. AR is considered to be durable, efficient, and easy to wear, which supports a hands-free interface compared to handheld scanners, which only allow one free hand to work. By employing this technology, virtual and real objects may be manipulated with both hands in the field of vision. Moreover, AR glasses are more practical and versatile than standard mobile devices and portable displays due to their features [11,15].

5 Result and discussion

Figure 3 represents the distribution of identified studies over the key findings, which were extracted from Table 1. The analysis from Figure 3 indicates that most research is giving more attention to productivity and operational efficiency, followed by ergonomic consideration and error reduction. About five to six studies focus on reducing distances and workers' motivation and training. Meanwhile, security and operation planning, and hardware or software improvement, receive very less attention from the researchers.

According to our review, the key findings of inventory optimization, new technology acceptance, demand forecasting, and external factor improvement in AR pick-by-vision have all been unexplored. Inventory optimization is the practise of having the right amount of inventory available to meet current and future demand. Achieving an ideal inventory level enables a company to not only fulfil demand projections but also reduce the expenses associated with common inventory issues such as backorders, overstocking, and stockouts. By enhancing stock workflows, AR may enhance the supply chain. Additionally, with this technology, workers may effectively scan multiple objects with a brief glance while the AR devices scan and record barcodes.

The acceptance of new technology indicates the success of implementation in terms of employing technology at various organizational levels as well as at the individual operator level [47]. Because it has the ability to relieve physical and psychological stress, technology acceptance has been generally acknowledged as an important driver for AR implementation [48,49]. External variables, on the other hand, are connected to improvements in certain scenarios, such as factory ambient illumination conditions, which may have a detrimental

affect on AR pick-by-vision performance and usability. Readers may get an insight into how this aspect might assist in boosting labour productivity and optimizing workflows in warehouse operations by evaluating new technology acceptance and improving external factors.

Besides, we also suggested that future research should explore the integration between AR and artificial intelligence (AI) to overcome the model-mismatch paradigm by establishing a complete feedback loop between the user and the robot. This integration could provide a solid foundation for raising the efficiency of the robotic application as well as improving the human operator's situational awareness, safety, and acceptance of AI robots.

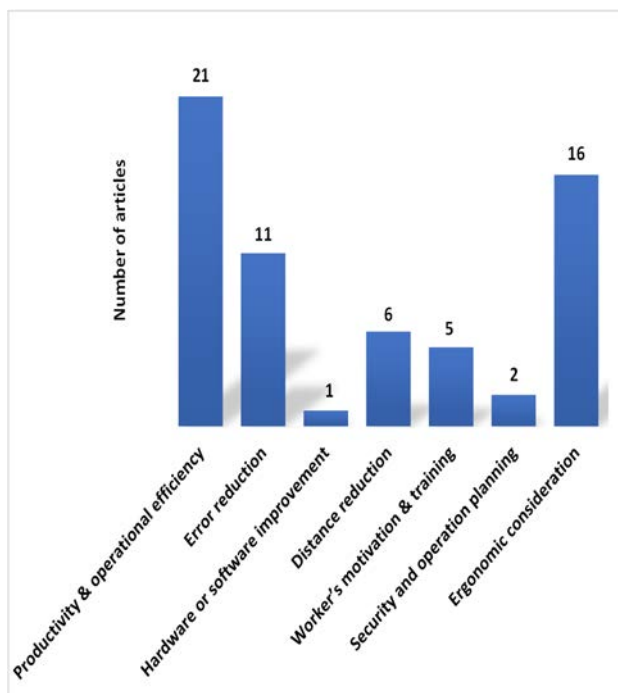


Figure 3 Distribution of identified studies over the key findings from Table 1

6 Conclusion

Over the last decade, the rate of advancement in AR pick-by-vision has been remarkable. In warehouse operations, the potential of AR pick-by-vision is undoubtedly immense, as it has the ability to transform ongoing operations and empower flexibility. For instance, AR pick-by-vision makes a substantial contribution to improving the overall efficiency of the warehouse operation. In fact, guided vision on mobile devices and AR smart glasses helps managers and employees optimize their workflows with a digital 3D warehouse guide.

This article dealt with review studies of AR pick-by-vision implementation in WMS to address the significance of AR in the order picking process. We found two gaps in the review studies, including the need for keyword search clarity as well as the need to review specific documents.

Besides, a hierarchical classification structure of AR implementation in WMS was produced, which emphasizes the pick-by-vision method in order to demonstrate the focus of the main area of the study.

The main contributions of this study are based on a survey of the literature, which attempts to address the two research questions in the context of the positive implication of AR pick-by-vision. The analysis of 23 articles (original articles and case studies) on AR pick-by-vision technology applications contributed to key findings with positive implications that can be used by both academics and professionals, especially those interested in optimising this new advanced technology for future research. The findings of our study are one of the outcomes that could be valuable in initial efforts to add to the growing literature and theory of AR pick-by-vision technologies and their usefulness in WMS order picking operations. In addition, we also identify the key findings that have not been fully explored as well as the limitations that the researchers may need to overcome in order to improve their work.

In the future, we could suggest that upcoming research look at the limitations, challenges, and managerial implications of using AR pick-by-vision in WMS. Additionally, future research could also explore the integration between AR and artificial intelligence (AI) in order to develop a strong foundation for increasing the effectiveness of the robotic application and for enhancing the human operator's situational awareness, safety, and acceptance of AI robots.

To conclude, improving the picking process in a warehouse demands a continual effort on the part of system suppliers and researchers to discover and analyze the capabilities of every current AR technology. Above all, the best strategy involves concentrating on a particular methodology for the development of the AR pick-by-vision system and carrying out a case study to investigate the impacts, opportunities, and risks of the extended process of utilising AR pick-by-vision in warehouse operations in order to achieve an extensive result.

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Assessing the major sources of uncertainty in supply chains: survey

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Abstract: Reducing uncertainty in the supply chain (SC) is probably one of the major difficulties that the company must solve. Indeed, the SC is currently under enormous pressure and the decision-making process is frequently confronted with varied settings while making decisions due to the degree of uncertainty. The purpose of this study is to investigate the main major sources of uncertainty in SC. The study also examines the practices adopted to reduce uncertainty and enhance forecasting accuracy. A survey was carried out. Questionnaires were distributed amongst the managerial staff located in Morocco and other countries. We collected work e-mail addresses of managerial staff managerial working in SCs that operate in mass production and also in large-scale distribution and invited them to participate in an anonymous online survey. The questionnaire was designed to assess respondents' views about the main sources of uncertainty in SC and how they do to reduce it. Findings indicate that uncertainty occurs in any SC process, but the main uncertain processes are procurement, supply planning, and demand forecasting. In addition, uncertainty comes from external and internal factors. Moreover, the decision-making mode, SC partnership, and risk contract have an important impact on the occurrence of uncertainty in the SC.

1 Introduction

In the economic sphere, uncertainty has an important effect on growth, inflation, and financial markets. This uncertainty is a result of several factors, such as market forecasting changes, the ambiguity of monetary policy and interest rates at the state level, the lack of clarity in the fiscal policy of governments in the face of deficits and surpluses, the unpredictability of policies, laws, and legislation associated with them, possible economic crises, etc.

In addition, reducing uncertainty is one of the intrinsic objectives of information sharing in SC. In an uncertain business environment, risk is always present [1]. Previous work tried to reduce the uncertainty rate by improving the accuracy of shared data, particularly that of forecasts. Thus, economic uncertainty has an impact on business investment decisions. If an economy's level of uncertainty rises, firms that want to invest may have to postpone their choice because they are unsure whether the firm's future cash flows will pay for the cost of the investment [2,3].

This research aims to investigate the major sources of uncertainty in SC, the SC factors involved, and the practices used to reduce it. The paper is divided into five sections. This introductory section of the article provides a general overview of the research required to create a hypothesis. The methodology, survey instrument, and data analysis are all discussed in Section 2. The results of the data analysis are presented in Section 3. Section 4 addresses the findings with regard to the previously stated hypothesis. Section 5 concludes with findings and recommendations for future research.

1.1 Related works

According to [4], uncertainty means that the economic environment of tomorrow is not known today. Uncertainty refers to a circumstance in which there is a complete lack of knowledge or understanding of a probable event's happening, regardless of whether the consequence is favorable or negative [5]. Some research is based on this particular assumption that the main source of risk and uncertainty was due to the difference in the attitude of decision-makers [6].

A typology based on certainty, risk, and uncertainty is presented by Lavoie [7]. In the situation of certainty, each option leads to a definite result with a known value. In the case of risk, each decision leads to a set of possible outcomes, each of which has a monetary value and a probability of occurrence. In contrast, in uncertainty, the set of possible choices is not necessarily known, the possible outcomes are not exhaustively known, nor are the values of these outcomes or the associated probabilities.

In the SC field, modeling uncertainty is a scientific discipline to which the scientific community pays close attention. Uncertainty can occur in any process in the SC. For instance, SC planning is a process dealing with the coordination and integration of a company's essential business activities, from raw material procurement to final product distribution to customers [8].

The problems of storage, production, marketing, procurement, inventory, distribution, transportation, reverse logistics, green logistics, etc., generate a great deal of uncertainty and cost overruns in companies; it is,

therefore, necessary to identify the factors that prevent the optimal development of logistics operations in organizations [9].

Several researchers have investigated the sources of uncertainty in a SC for instance, [10] divided them into three categories: demand uncertainty, manufacturing process uncertainty, such as machine malfunctions, and supplier uncertainty, such as delivery delays. Many uncertain incidents disrupted SC activities. These incidents could be internal or external. Each aspect of uncertainty has disrupted SCM [11]. Moreover, [12] surveyed high-tech companies to identify the factors of technological uncertainty in an SC that ultimately affect overall cost and quality.

Forecasting errors are a source of uncertainty in SCM. Indeed, forecast management is one of the key driving factors in planning and decision-making for any SCM [13]. These errors generate a big gap between the real values and the expected ones. Thus, a good forecasting model could be efficient for dealing with forecasting errors. In addition, [14] examined retailer decisions (forecasting and replenishment models) and supplier decisions regarding the production decisions of the supplier. The results show that the selection of the forecasting model influences SC performance and information sharing. Their finding is aligned with those [15]. Indeed, [15] considered that the demand for finished products is a random variable whose expectation and variance are known. They found that the first source of uncertainty in material requirement planning is that relating to demand. The demand comes from outside and varies depending on a variety of factors (seasonality, culture, natural disasters, political conflicts, etc...). Because demand is affected by wider economic and political factors [16]. More accurate and precise predictions provide visibility on demand and hence ensure efficient SCM, decreasing the influence of market volatility and uncertainty on demand. To counter uncertainty, [15] proposed sizing a safety stock for each component for a predetermined probability of failure. The mathematical expectation and variance of the component demand are obtained by simply summing the expectations and variance of the demands of the finished products that use them.

1.2 Uncertainty and information sharing in SCM

Information sharing is a hot topic in SCM that has emerged as a result of the integration of new information and communication technologies. Information sharing is one of the well-known mechanisms for reducing uncertainty in SCM. The better information sharing is, the more uncertainty is reduced. Asymmetric, incomplete, or inaccurate information is frequently cited as a contributing factor to SC uncertainty and inefficiency. Therefore, uncertain factors in SC can cause more serious information distortion and lower the performance of SC [17].

Decision mode is an essential element in the information-sharing process. For managing a SC, there are

two types of decision modes: centralized and decentralized mode. The firm chooses the appropriate one according to the goals previously established. These two types are largely studied in the literature.

The centralized decision mode is the mode in which the manager at the top of the structure makes all of the decisions, and all information must go back to him to help him make the best decision possible. Different levels of centralization can be used to manage SC. For instance, the vendor-managed inventory program (VMI) is an example of a centralized SC in which the supplier makes inventory control choices for both the supplier and the customer [18], [19]. High centralization has proved to be valuable for managing complex problems [20].

On the other hand, there is the decentralized decision mode, in which independent work units have autonomy in decision-making. The decentralized mode can represent more viable and less cumbersome coordination than centralized coordination because each entity retains its autonomy [21]. It allows the organization to react quickly to changing local conditions [22].

SC partnerships are also involved in the information-sharing process. The characteristics of SC partnerships have been extensively studied in the literature [23-26]. Customer and supplier relationships are one of the most important ones. The interaction with external partners to create inter-organizational strategies, practices, and activities into synchronized collaborative processes is known as customer and supplier integration [27]. It comprises strategic communication and interaction, information system capabilities, collaborative planning activities, and information sharing about planning [28]. In addition, the competitive advantage is gained by organizations that have committed relationships with their customers [29]. The relationship with the supplier is purposefully and naturally strategic, and it primarily involves the organization's top management. It is because the market is highly complex and enterprises' resources are limited [30].

According to [31] shared information is exploited for both purposes: better supplier replenishments and better allocations to the retailers. The traditional method of supply is to have a large number of suppliers. Even when the buyer provides comprehensive technical specifications, there is typically limited contact and information exchange. For the buyer, this relationship offers benefits such as easy switching between providers, lower costs, having the supplier act as a shock absorber, and not disclosing personal information [32]. In addition, the value of information sharing could be influenced by whether the information is shared with only a limited number of a company's customers and not with many small customers.

Moreover, [33] allowed a firm to manage all of its operational operations by combining various management functions into one system: order management, inventory management, payroll and accounting management, e-commerce management, etc. Companies can progress

towards an extended enterprise business model by implementing ERP, which increases value across the whole SC. Indeed, companies must share a huge amount of planning and operational data, ranging from information for annual contracts and periodic progress reports to real-time delivery and invoicing data, to obtain SC efficiencies.

Furthermore, [34] emphasized the goal of management software packages to reduce the uncertainty of information by working on four important aspects: availability, representability (accuracy of the information concerning the message to be transmitted), the delay between the occurrence of an event and its consideration, and the periodicity of information renewal.

Risk contracts are mentioned in many previous works as an essential element involved in information sharing in SCM [35-38].

Risk contracting is necessary for an uncertain environment where the risk rate is high. Today, the contract is announced as a model of modern management, in which all economic and even political actors and stockholders seem to want to be involved [39]. Risks occur because people never know exactly what will happen in the future. People can use the best forecasts and do every possible analysis, but there is always uncertainty about future events [33]. Consequently, [40] proposed to contractualize the notion of risk between customer and supplier to improve the overall profit of the SC actors because it allows them to legally bind the stakeholders around one or several objectives [41]. The presence of risk is unavoidable in any project, and it can be tough to identify at times. When a SC enters into a risk contract with a supplier or retailer, the main goal is to reduce the project's risk. They then agree on a set of clauses. This strategy has the potential to protect SC or even put SC in an embarrassing situation. As a result, it is strongly advised to carefully discuss the clauses with the partner(s).

1.3 Hypothesis formulation

Based on the above, the following hypotheses are postulated:

- **H1:** *There is a relationship between uncertainty and the decision mode*
- **H2:** *There is a relationship between The supplier and retailer's numbers and uncertainty.*
- **H3:** *There is a relationship between uncertainty and using an ERP.*
- **H4:** *Using a specific tool for reducing forecast errors affects uncertainty in SC.*
- **H5:** *There is a relationship between Risk contracting and uncertainty.*

2 Methodology

2.1 Survey instrument

2.1.1 Questionnaire design

A questionnaire is the primary research instrument for this study. Questionnaires are considered to be a successful

method for collecting information from respondents, particularly when the researcher understands what is needed and how to measure the variables of interest.

The questionnaire was divided into three main parts. The first part was based on the respondent's profile, including gender, country, and position. The second part was based on the SC profile, including legal status, sector, company structure, and decision mode. The third part concerned the origin of uncertainty in the SC and how to reduce it.

The questionnaire consists of 23 questions that are checkbox questions, multiple-choice questions, open-ended questions, and Likert scale questions.

2.1.2 Questionnaire elaboration

Based on the literature and the hypothesis, the initial version of the questionnaire was created. This version was given to three experts for assessment and evaluation of the structure and content. The questionnaire was modified following their feedback and then sent to 8 researchers (SC analysts, statisticians, and data scientists) from four universities for further refinement.

The original survey was designed in French. The French version is needed since the survey sample targeted managerial staff who graduated from Moroccan universities. A version of English is designed for all researchers. The French questionnaire was translated into English by the first author for analysis. Based on the suggestions received from the respondents after the first release of the online survey, the questionnaire is improved even more by adding some options.

2.2 Profile of the participants

Our study targeted staff working in SCs that operate in mass production and also in large-scale distribution. The questionnaire is shared with an updated database from ANAPEC (National Agency for the Promotion of Employment and Skills), a Moroccan public institution in charge of accompanying job seekers in their search for work and meeting the recruitment needs of companies.

Moreover, questionnaires were sent by e-mail to the professors, associate professors, assistant professors, postdoctoral researchers, and all graduated students of the Laboratory of Engineering, Industrial Management and Innovation IMII whose e-mail addresses were available on the Hassan First University in Morocco website. The anonymity of participants was guaranteed. Reminders were sent after 2 weeks. Data were collected from May 2021 to September 2021.

The e-mail was sent with "Questionnaire pour Recherche Doctorale" as the subject of the e-mail explaining the purpose of the study and providing a link to the online questionnaire (French version and English version) to all the target researchers.

2.3 Statistical methodology

The authors obtained 151 valid responses. Data were collected, categorized, and coded in SPSS before being analyzed. The data is divided into two groups numerical values and categorical values.

Comparisons between variables were performed using the Chi-square test for the binary variable (uncertainty) and categorical variables (using ERP, Risk contract, Tool/mechanism for reducing uncertainty, Decision mode, customer and supplier number). In general, the null hypotheses were that our variables do not affect uncertainty in SC.

We formulate our test:

H0: the variables are independent

H1#H0

If the $p\text{-value} \leq 0.05$, we reject H0 and therefore accept H1, which states that the two variables are related.

3 Result

We sent a total of 3200 e-mails, and 695 e-mails were bounced back in the first release. These addresses to which e-mails were not delivered successfully were regarded as invalid addresses. For the second round, we sent reminder e-mails to the other valid e-mails. Only complete responses and responses with fewer than two invalid answers were included. After eliminating incomplete responses, 151 completed questionnaires were analyzed.

3.1 Demographic information

According to the demographic characteristics of the respondents, the majority of respondents were male (66.2%). The respondents were mainly Logistics Planners (senior or junior) (20.5%), Inventory Managers (15.2%), SC researchers (12.6%), Freight Agent / Import-Export Operations Agents (9.9%), logistic assistants (9.3%), Warehouse Manager (8.6%) and Procurement Manager (7.3%). More than 80% of the respondents live in Morocco, and 10.6% live in Europe (5.30% lives in France, 2.00% in Switzerland, and 1.30% in Germany).

3.2 Characteristics of supply chains

Concerning SC's legal status, 41% of respondents worked in a Limited company (SA) and 38% in a Limited liability company (SARL). 6% and 3% of respondents worked, respectively, in a Limited liability company (LLC) and General partnership (SNC).

In the context of the economic sectors, 21% of the companies belong to the Automotive industries and 18% belong to Food, beverage, and tobacco industries. 9% of SCs belong to the Mechanical, electrical, and telecommunications sector and 6% belong to the building materials sector. The Chemical Industries and Energy sectors are made up of 5% of companies in each of the two sectors. 4% belong to the Plastic industries sector while Aeronautics, Wood; pulp and paper, Cosmetic and fashion industries, Mining (coal; other mines), and Petrochemical industries are made up of 3% of companies in each one.

72% of the firms used the centralized decision-making mode, while 42% used the decentralized mode. The main structure for the SC structure is the convergent network (38%). 23% of SCs structures were serial networks and 19% were divergent networks.

Given the characteristics of SCs, we analyzed variables to discover any relationship between these characteristics and the uncertainty in SC. The analysis was performed using the Chi-square test for binary variables (uncertainty in SC) and categorical variables (economic sector, decision-making mode, and SC structure).

3.2.1 Cross analysis between "uncertainty" and "Economic sector", "supply chain structure" and "decision-making mode"

In table 1, we want to know if the uncertainty is related to the nature of our study's economic sector, SC structure, and decision-making mode.

According to the results. It is noticed that the probability obtained with the Chi-square test is equal to $0.448 > 0.05$. We accept the null hypothesis of independence, which implies no relationship between the two variables. So economic sector has no impact on the uncertainty.

For SC structure, the p-value of this Chi-square test is 0.760. Consequently, we accept the null hypothesis of independence, so the SC structure has no impact on the uncertainty in SC.

In contrast, for the decision-making mode, the p-value of this test is 0.000, and it is significant at the 5% threshold. We, therefore, reject the null hypothesis, which assumes that the two variables are independent and we conclude that the two variables are dependent and we conclude that the uncertainty and the decision-making mode are linked. The straightness of this relationship is examined as well. In table 2, the value of Cramer's V is 88.6% which shows that the relationship between uncertainty and decision-making mode is strong. So, the first hypothesis H1 is verified.

Table 1 Cross analysis between "uncertainty" and "economic sector", "supply chain structure" and "decision-making mode"

	Chi-square test
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		Val	ddl	Asymptotic significance (bilateral)
Economic sector	Pearson's chi-square	22,205 ^a	22	,448
	Likelihood ratio	26,912	22	,215
	N of valid observations	151		
	a. 36 cells (78.3%) have a theoretical size lower than 5. The minimum theoretical size is .28.			
supply chain structure	Pearson's chi-square	1,172 ^b	3	,760
	Likelihood ratio	1,176	3	,759
	N of valid observations	151		
	b.0 cells (0.0%) have a theoretical number less than 5. The minimum theoretical size is 8.26.			
decision-making modez	Pearson's chi-square	118,404	1	,000
	Correction for continuity	114,066	1	,000
	Likelihood ratio	124,508	1	,000
	Fisher's exact test			

Table 2 Symmetrical measurements

		Val	Approximate Signification
Nominal by Nominal	Phi	-,886	,000
	Cramer's V	,886	,000
N of valid observations		151	

3.3 Uncertainty sources (outside or inside of SCM)

Concerning online sources, 76.2% of the respondents reported that the uncertainty comes from external and internal factors, (14%) reported that it comes from External factors, while fewer (9%) reported that it comes from internal factors.

3.4 Working with more than one supplier/customer effect

3.4.1 supplier/customer number effect

The relationship between the number of supplier/customer and uncertainty were examined as well. According to the results, a substantial number (57%) of respondents reported that having more than one supplier decreases uncertainty. In contrast, almost half of the

respondents (47%) indicated that having more than one customer increase uncertainty. In addition, 35.1% of respondents indicated that working with more than one customer decrease uncertainty, whereas 29.8% indicated that working with more than one supplier increases uncertainty. Fewer (17.9% and 12.6%) indicated that the number of relationship partners (customers and respectively suppliers) is without effect.

3.4.2 Cross-analysis between "uncertainty" and "supplier/customer"

The cross-tabulation in Figure 1 displays uncertainty by the number of suppliers and customers. This number is represented by an interval. Figure 1 shows that uncertainty is strongly correlated with the number of suppliers between [31,50] and customers number which is more than 30.

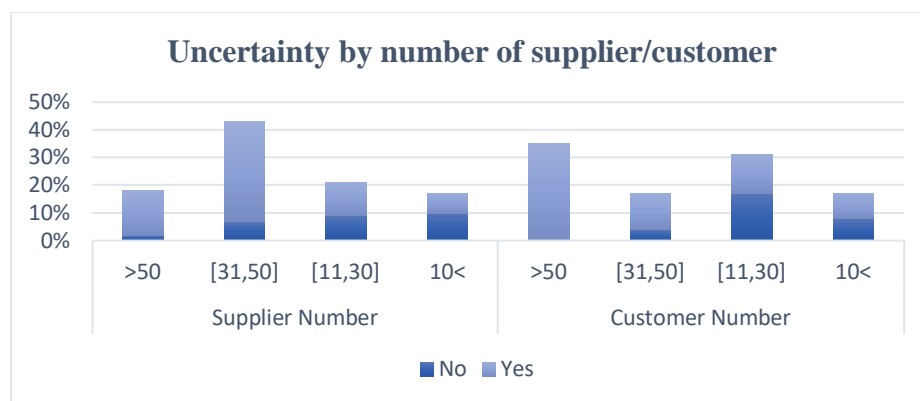


Figure 1 Cross analysis between "uncertainty" and "supplier" and "customer number"

Table 3 displays the Chi-square test for number, The p-value of this test is 0.000, and it is significant. We, therefore, reject the null hypothesis, which

assumes that the two variables are independent, and we conclude that the two variables are dependent and we conclude that the level of uncertainty and supplier number are related. Table 4 shows that Cramer's'V value is 51.8% which means a moderated relationship.

For the customer number, The p-value of this test is 0.000 (Table 3). Then we conclude that the two variables are

dependent. Table 4 shows that Cramer's'V value is 39.1% which means a moderated relationship. According to this finding, we can conclude that supplier/customer numbers affect uncertainty in SC. The more suppliers/customer increases, the more the uncertainty level change. H2 verified.

Table 3 The relationship between uncertainty and supplier/customer number

Chi-square test						
	Supplier Number			Customer Number		
	Val	ddl	Asymptotic significance (bilateral)	Val	ddl	Asymptotic significance (bilateral)
Pearson's chi-square	40,579 ^a	3	0,000	23,078 ^a	3	0,000
Likelihood ratio	53,013	3	0,000	22,818	3	0,000
N of valid observations	151			151		

Table 4 Symmetrical measurements

	Supplier		Customer	
	Val	Approximate significance	Val	Approximate significance
Phi	0,518	0,000	0,391	0,000
Cramer's V	0,518	0,000	0,391	0,000
Total	151		151	

3.5 Uncertain processes

On a scale of 0 to 3, each SC process was evaluated for its degree of uncertainty (0 being the least uncertain and 3 being the most uncertain).

According to our findings, demand forecasting is the most uncertain process (Figure 2). 19% of respondents indicated that demand forecasting is the most uncertain, whereas 15% indicated Supply planning.

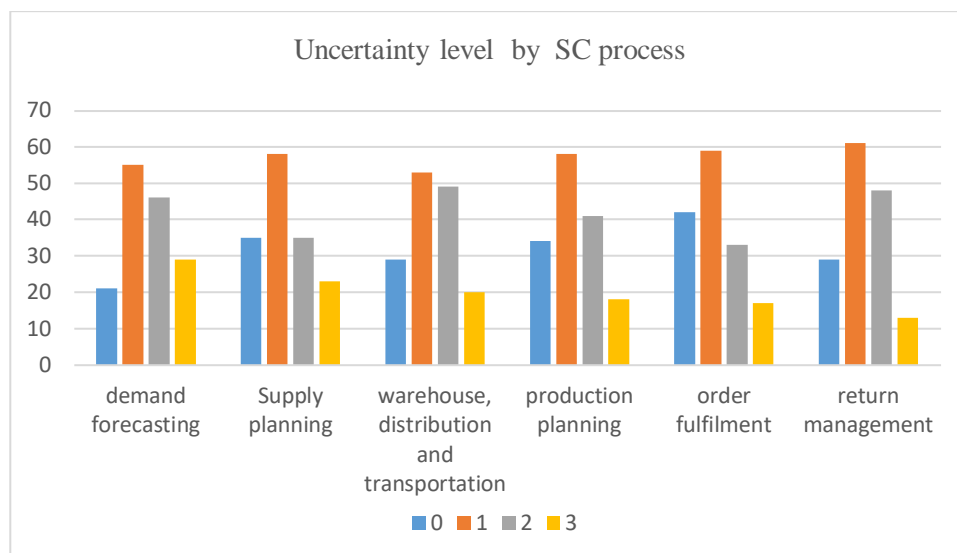


Figure 2 Uncertainty by process

Indeed, [42] has developed a theoretical review for SC uncertainty. This review identifies a list of 14 sources of uncertainty, including those that have received much

research attention. Based on the result of their analysis, their finding was included in the study to classify different uncertainty factors according to their importance.

Figure 3 displays a classification of uncertainty factors identified by [42]. 12% of respondents tended to agree that the suppliers are the main factors of uncertainty, while product characteristics and end-customer demand are made up of 10% of factors for each one. The manufacturing process, Cost forecasting horizon, Environment and

Policy, Complexity of the decision, and Disaster are likely to have the same level of uncertainty. At the practical level, more than half of the respondents stated that the most critical factors are related to procurement, product characteristics, and demand forecasting processes.

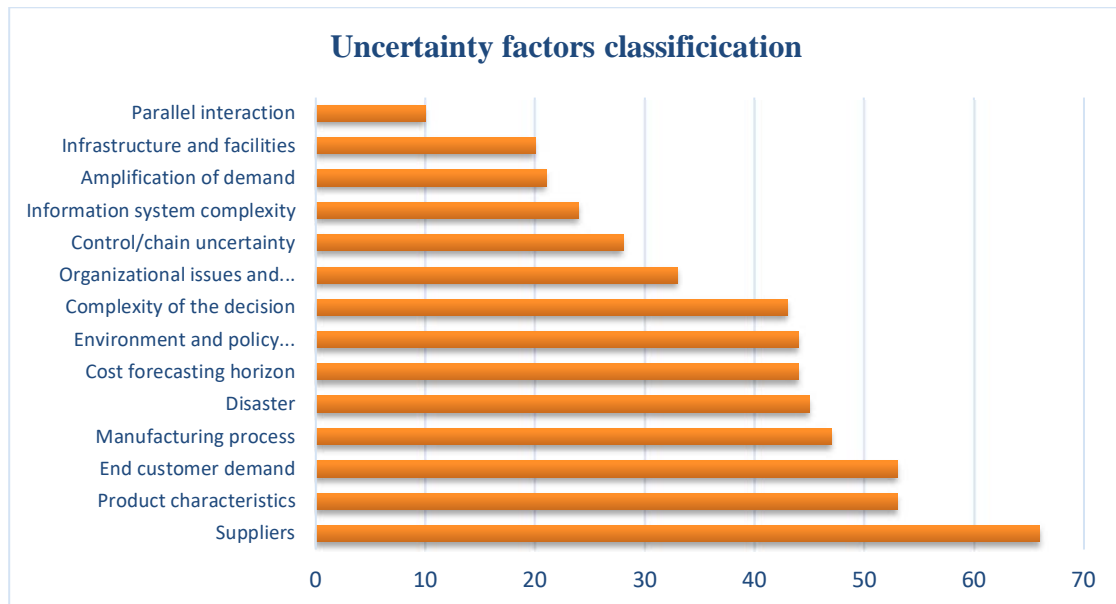


Figure 3 Uncertainty factors classification

3.6 Reducing uncertainty in SC

According to Figure 4, 66.2 % of respondents indicated that they use an ERP for forecasting management, and 84% of them use a specific tool to reduce errors generated by forecasts. Some responders mentioned some mechanisms for correcting forecast errors, such as the contingency plan,

standard operating procedures, and kick-off meetings. Collaborative communication between different SC stages is also cited as a corrector of errors related to uncertainty. To mitigate forecast uncertainty and share the damage due to uncertainty, some firms use a risk contract with customers and/or suppliers. 72.8% reported using the risk contract with SC partnerships.

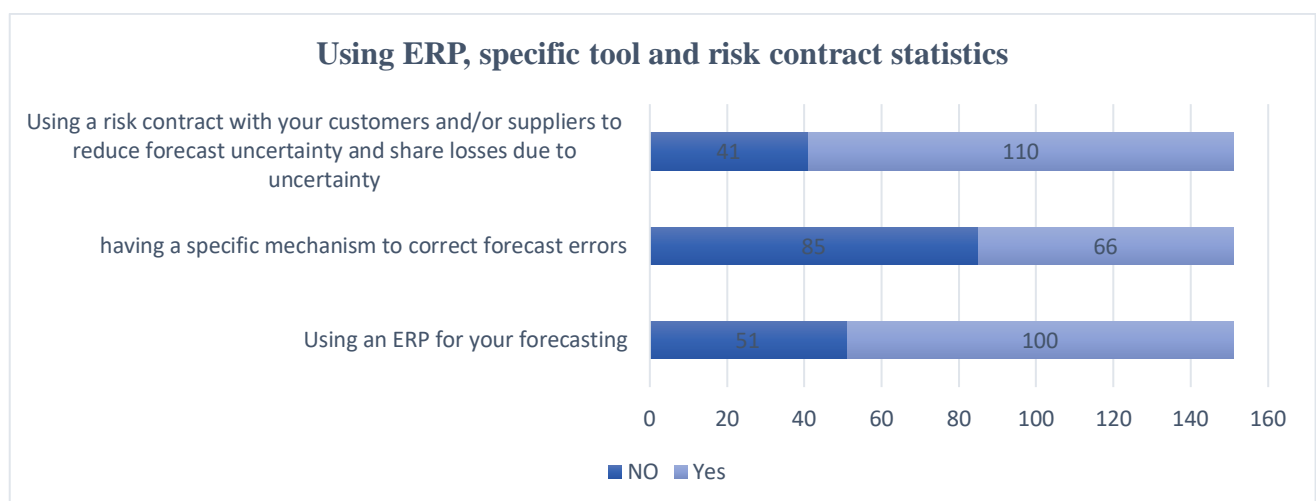


Figure 4 Using ERP, Specific tools, and Risk contract statistics

3.6.1 Cross analysis between "uncertainty" and the use of "ERP", "a tool for forecasts errors" and "risk contract"

In this part, a Chi-square test is done to discover the relationship between uncertainty and the use of ERP, tool,

and risk contract. For the use of an ERP, according to table 5, The p-value of this Chi-square test is 0.573. we, therefore, accept the null hypothesis and we conclude that the level of uncertainty and the use of an ERP is not related. H3 verified.

Table 5 The relationship between uncertainty and ERP, a tool used for reducing uncertainty and Risk contract

		Val	ddl	Asymptotic significance (bilateral)
ERP	Pearson's chi-square	,317	1	,573
	Correction for continuity	,139	1	,710
	Likelihood ratio	,314	1	,575
	Fisher's exact test			
	N of valid observations	151		
The tool used for reducing uncertainty	Pearson's chi-square	53,963	2	,000
	Likelihood ratio	58,951	2	,000
	N of valid observations	151		
Risk contract	Pearson's chi-square	67,905	1	,000
	Correction for continuity	64,605	1	,000
	Likelihood ratio	65,741	1	,000
	Fisher's exact test			
	N of valid observations	151		

It seems that the use of a specific tool for reducing forecasting inaccuracy could be beneficial. This assumption is examined as well. According to Table 5, the p-value of this test is 0.000. We reject the null hypothesis, which assumes that the two variables are independent and we conclude that the use of a specific tool for reducing forecasting uncertainty has a tangible effect on uncertainty

in SC. Table 6 shows that Cramer's V value is 59.8% which means the relationship is relatively strong. H4 verified.

The relationship between Risk contracts and uncertainty is examined as well. The p-value of this test is 0.000 (Table 5), we reject the null hypothesis, and we conclude that the use of a Risk contract affects uncertainty in SC. Table 6 shows that the Cramer's V value is 67.1% which means the relationship is strong. H5 verified.

Table 6: Symmetrical measurements

		Val	Approximate significance
The specific Tool	Nominal by Nominal	Phi	,598
		Cramer's V	,598
	N of valid observations		151
Risk Contract And Uncertainty	Nominal by Nominal	Phi	,671
		Cramer's V	,671
	N of valid observations		151

4 Discussion

Indeed, SCs are confronted with various risks that are hard to assess. According to [43], there are two types of risk in SC; internal risk and external risk. External risk comes from outside the SC; usually related to economic, social, governmental, and climate factors, including the threat of terrorism, and also caused by factors such as a supplier's financial or management stability, or the purchase and sale of supplier companies. Internal risk is caused by disruptions of internal operations or processes, by changes in key personnel, management, reporting structures, or business processes, such as the way purchasers communicate to suppliers and customers, and

by inadequate assessment and planning, which amount to ineffective management. The results of the study discovered that uncertainty came from both internal and external factors.

This finding is aligned with many works. Indeed, [44] describe four sources of uncertainty: physical manifestations, perceptions, behavioral response repertoire, and social expectations. However, [33] examines the impacts of SC and risk on the logistics performance in the Australian courier industry and indicates that the greatest impact of SC uncertainty comes from an outside company.

In addition, [42] identified a comprehensive list of 14 sources of uncertainty, including those that have received a lot of attention in the past, such as the whiplash effect, as well as those that have only recently been described, such as parallel interaction. Techniques for controlling these sources of uncertainty are divided into two categories: ten approaches that aim to minimize uncertainty from its source, and eleven approaches that aim to manage uncertainty while reducing its impact on performance. Manufacturing strategy theory, which includes the ideas of alignment and contingency, is then applied to the development of an SC uncertainty model, which is then fed with data from the literature review to demonstrate alignment between sources of uncertainty. According to his work, [42] has divided the origins of uncertainty into three categories: (1) Internal organization uncertainty, which includes product characteristics, manufacturing process, control/chaos, decision complexity, organizational/behavioral challenges, and information technologies IT complexity. (2) Internal SC uncertainty, which includes end-customer demand, demand amplification, supplier, parallel interaction, order forecast horizon, chain configuration, infrastructure, and facilities, and is within the control domain of the focal company or its SC partners. (3) External uncertainties arise from elements outside the SC that are beyond a company's direct control, such as government regulations, competitor behavior, and macroeconomic concerns, as well as disasters, such as earthquakes, hurricanes, and high sea waves.

Moreover, it is found that the most uncertain SC process is procurement. This topic is largely studied in the literature [45-48]. According to [46] the importance of procurement in the SC can be realized from the percentage of the cost it takes in the industry. They noticed that procurement risk is the probability of variance associated with supply disruption in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to the subsequent process in the SC operation. As there is no systematic way for managers to classify the source of procurement risk once the unexpected risk has happened, procurement risk has primarily relied on the manager's expertise and intuition [46].

From our results, it is clear that the mode of decision-making has an impact on the occurrence of uncertainty in the SC.

Centralization can be considered the most powerful mechanism to coordinate decisions in the organization. All decisions are made within the same structure, which ensures consistency of decisions and better results concerning the overall goals of the SC [49]. However, the decentralized mode may represent more viable and less cumbersome coordination than centralized coordination because each entity retains its autonomy. Moreover, it allows the organization to respond quickly to changing local conditions [50]. Even if the centralization reduces the

uncertainty in the SC, it doesn't eliminate the increase in variability [51,52].

Consequently, the choice of one of the two modes is a crucial choice for managers because, from the above, each mode has its advantages and has its disadvantages. Thus, the company can decide on the right mode to improve the information sharing in their SC, reducing uncertainty and ensuring the survival of the SC.

From the Chi-square tests between uncertainty and the number of suppliers and customers, we conclude that there is a strong relationship between them. Therefore, the number of suppliers and the number of customers influence uncertainty by then sharing information in the SC.

Some works are aligned with this finding. Indeed, [53] showed that the value of information sharing decreases when the number of customers increases. As the number of customers increases, the random variation in demand tends to balance out, reducing the value of information sharing. The value of information sharing is influenced when information is shared with a limited number of customers of a firm and not with large small customers.

Furthermore, having multiple suppliers can be advantageous because they can reduce not only the uncertainty of obtaining materials or products for the retailer but also the wholesale price due to competition among suppliers, the uncertainty of delivery time, and the cost of a shortage caused by a single supplier [54-56].

According to the results, the impact of using ERP and a specific mechanism to correct forecast errors on uncertainty is small.

Some responders mentioned some mechanisms for correcting forecast errors. They mentioned the contingency plan, S&OP, and kick-off meetings. S&OP (Sales and Operations Planning) is a method of creating tactical plans that allow management to strategically guide their company to achieve a competitive advantage. The goal is to combine a customer-focused marketing strategy for new and existing items with SC management regularly.

A kick-off is the initial meeting between a project team and a client or stakeholder to discuss project fundamentals and general planning activities. The project kick-off meeting is usually held just before the start of project execution. The project kick-off meeting is an important tool in the formulation of a project management strategy.

Based on the answers, the Kick-off mistakes can be rectified and anticipated eventual errors can be in advance. Thus, a checklist is essential to list and store the errors that have been reported with their solutions.

Collaborative communication between the bodies in the chain is also cited as a corrector of errors related to uncertainty.

It is found that there is a strong relationship between the use of risk contracts with customers and/or suppliers to reduce forecast uncertainty and share losses due to uncertainty. We can therefore answer our hypothesis and say that the existence of a risk contract reduces uncertainty.

Indeed, global market conditions, marked by increased and fierce competition, have forced SCs to modify their risk management strategies. More specifically, SCs must develop strong contractual mechanisms to manage uncertainty and fluctuating demand. For instance, [57] developed a risk-sharing contract in a SC to study strategic and vital components exposed to the combined risk of demand uncertainty and price volatility. The proposed contract guides establishing a long-term SC contract to mitigate known and unknown risks. In addition, [58] proposed a risk-sharing contract that requires the retailer to partially compensate the manufacturer's loss due to overproduction and the manufacturer to provide partial credit for the retailer's loss due to overstocking. Moreover, [58] proposes contracting the risk between the customer and supplier to improve the overall profit of SC actors. To mitigate the risk, [59] suggested combining contract and open market to obtain the optimum procurement under the uncertain market price.

Respondents cited other sources of uncertainty that may be useful for future research. Lack of communication, especially with management, was the most mentioned. Other sources related to the political and legal situation, such as the complexity of laws and bureaucracy. The constraints of the economic market are also cited; the fluctuation of needs, the hazards at the level of the prices practiced in the market, customs, international politics, insurance, environmental factors, and macroeconomics.

To minimize uncertainty errors, respondents left some recommendations. They recommend the proximity of customers-suppliers because the basis of SC planning is the sales forecast and suppliers. They thought it was imperative to control these two first before moving on to the remainder.

In addition, the reliability of the forecast models must be checked. A rate of uncertainty should be applied to avoid disruptions of upstream operations; on the other hand, a demand forecast with a better rate of accuracy will allow the minimization of the costs necessary to allocate to face the hazards (raw material breakage, underestimated production capacity...).

On the relational side, they propose coordination and collaboration through information systems that govern and organize relationships and information between stakeholders.

They also recommend risk assessment before and during procurement and having a maintenance management system that guarantees the start-up in real-time and developing a risk-sharing contract to study strategic and vital components exposed to the combined risk of demand uncertainty and price volatility. The proposed contract guides establishing a long-term SC contract to mitigate known and unknown risks.

5 Conclusion

The challenges of information sharing and eliminating -or reducing- uncertainty in SCs is one of the important

issues, and it prompts SCs to study possible ways. The current study aims to explore the different sources of uncertainty in SCs, the main factors involved, the most uncertain process, and the policies adopted to reduce uncertainty. A survey was conducted to answer our problem. Through our online survey among SC researchers, we have answered and validated the hypothesis previously formulated.

The main contribution of this chapter is to know the closeness between the problem of uncertainty in the working area and what is already studied in the literature and to what extent this closeness is reached. This study recommends certain practices that can reduce the level of uncertainty. Good communication is a witness between others.

Rationally, every research output is followed certain limitations. Similarly, this article possesses some limitations. However, sufficient attention was taken to increasing our survey sample. We recognize that the relatively low number of respondents affects the generalizability of our study. Moreover, this survey was done in 2021, So these results are relatively affected by inflation taking hold in Morocco as well as around the world.

In summary, the overall results indicate that uncertainty in SC is an interesting area that requires further research.

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The role of information and digital tools in supply chain management during the Covid crisis

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Abstract: Supply chains have become the most vulnerable during the COVID-19 pandemic, as evidenced by problems in the supply of semiconductors, food, and other products, which raises the problem of supply chain manageability. There has been a so-called 'shortening' of the supply chain. The paper addressed the problem of using digital tools in small and medium-sized enterprises (SMEs). The study aims to examine the main digital tools used by local businesses and evaluate the prospects for logistics management using new technology. The hypothesis is that SMEs that do not use digital tools in supply chain management are also characterized by the poor quality of management. A survey was conducted to identify the actual supply chain management practices during the COVID-19-induced crisis in the Russian Federation, the Republic of Azerbaijan, and the Republic of Kazakhstan and discover common trends and differences in these countries. A set of recommendations for implementing best global practices in these countries was suggested. The study found that poor supply chain management correlates with a lack of digital tools application. The studied enterprises were divided into five groups based on the digital tools level and provided tailored recommendations to improve the integration of such tools.

1 Introduction

The globalization trend of the world economy contributed to the formation and development of global supply chains. However, the COVID-19 pandemic has led to an unprecedented halt or slowdown in production in virtually all industries worldwide, threatening the functioning of global supply chains. International supply chains are in crisis, despite all the efforts of businesses and nations to overcome the effects of COVID-19. Structural distortions and imbalances are present in the container market, maritime logistics, port operations, air freight, road and rail freight, and even warehouse logistics. These imbalances have resulted in shortages of crucial manufacturing components, backlogs in pre-orders, delayed deliveries, rising transportation costs and consumer prices.

The real problems in supply chain operations began at the end of 2020 [1,2]. Restarting production after the lockdown proved to be a non-trivial logistical challenge. A complex logistics system moving raw materials,

components, and finished goods worldwide required predictability and precision. There was a shortage of transport containers, tariffs rose rapidly on some routes (especially from China, Indonesia, and South Korea), and traffic jams formed at international ports, spreading to railroads and domestic terminals. Importers faced delays in obtaining key production components, and exporters faced problems accessing containers and booking space on seagoing vessels [3].

The COVID-19 pandemic is no ordinary short-term crisis. It has long-term implications for both people and supply chain operations. It requires a holistic approach to supply chain management. Companies must be flexible enough to make management decisions. This approach must be based on the latest technologies and platforms that support applied analytics, artificial intelligence, and machine learning. It should also provide end-to-end transparency across the entire supply chain. Risk response should become an integral part of standard protocols in the long run. Thus, research toward digitalization and

transformation of global supply chains remains relevant, considering new challenges and threats (e.g., COVID-19).

1.1 Literature review

It is necessary to separate the criteria of supply chain reliability (ability to continue working through crisis) from the criteria of sustainability (ability to recover from the crisis) [2,4]. The consequences of the COVID-19 pandemic on the development of global supply chains can be considered through the prism of new world economy trends – the regionalization of production and market diversification, which lead to localization and reduction of supply chains. One of the consequences of the COVID-19 pandemic may be the exit of weak players from the logistics market, which, in turn, can cause bankruptcies, acquisitions, and mergers [5]. At the same time, there is likely to be a consolidation of the sustainable companies' market share. The main problems in the global economy after the pandemic are [6]:

- 1) sharp spikes in demand in specific segments (fall and growth);
- 2) supply shortages;
- 3) inventory allocation problems;
- 4) productivity declines.

The transformation of the traditional linear supply chain logistics model into digital networks that provide end-to-end visibility, responsiveness, and the ability to optimize current processes is expected to accelerate. Therefore, new global supply chain development technologies are now emerging that significantly improve the visibility of the entire chain and support the ability of companies to withstand such shocks. Today's environment requires a fundamentally new supply chain model. Years of emphasis on supply chain optimization to minimize costs, reduce inventory, and increase asset utilization show that many companies have not prepared for such shocks and supply chains [6]. Crisis management involves urgent priority decisions once a problem has been identified. These priorities are [7,8]:

- a) improving staff productivity;
- b) using data to ensure transparency of demand, inventory, production capacity, supply, and finance;
- c) market segmentation to prioritize demand;
- d) creation of crisis sales and operations teams that can effectively respond to the challenges at hand;
- e) modelling and evaluating different supply chain scenarios. Modelling is essential for anticipating when and where surpluses and shortages may occur and obtaining initial information that optimizes operational performance.

The World Bank identifies the following key barriers hindering supply chain development in the COVID-19 pandemic [1]:

- non-diversification of supply chains, which in turn leads to instability in the organization of logistics activities;
- the geographic spread of supply chains, their rigidity, and lack of coordination;

- China's role as the 'world's factory' means that a significant disruption in the Chinese market threatens global supply chains.

WTO considered the pandemic's impact on general processes in the world economy (particularly on logistics), analyzed trends in global trade volumes, and presented two plausible scenarios of development [9]. The first scenario is a repeat of the COVID-19 outbreak. This development would require a series of further blockages, affecting fiscal policy and exacerbating labour market problems. The second scenario involves the absence of outbreaks. It would facilitate rapid and robust growth in production and trade. Other positive factors include the emergence of new technology sectors, such as artificial intelligence and e-commerce, the increased use of innovation in traditional industries, which would be forced to make greater use of information technology to deliver goods and services to customers during the pandemic.

During recovery from the coronavirus crisis, the main driver of supply chain management is digital technology [5,10]. Supply chains can be strengthened through the following tools:

1) E-commerce. Against a backdrop of waning economic activity, the pandemic led to a surge in e-commerce and an acceleration of digital transformation. After quarantine measures became the 'new norm', businesses and consumers became much more active in digitalization. Today, major consumer purchases are made online [5];

2) Real-time tracking. Cargo tracking, automated warehouses, GPS, and RFID (radio frequency identification) are technologies that track the movement of personnel, equipment and inventory, collect data and improve visibility [11];

3) Interference levelling using artificial intelligence (AI) technologies. Artificial intelligence is used in logistics to analyze and select the fastest and cheapest delivery routes. In addition, there are technologies such as an automated pallet management system designed to reduce shipment processing time. Such a system allows for complete automating of pallet storage processes, transporting loaded pallets, and integrating warehouse and production processes. The automated pallet management system can be used in transportation hubs, factories, warehouses, and distribution centers [12];

4) Digital supply network. The traditional supply network can be a more open and accessible digital supply network (DSN) powered by AI, analytics, robotics, sensors, and algorithms. DSN collects physical reality data, creates a digital record of it, and allows information to be shared, analyzed and turned into action that can be carried out in the real world. Such technology improves communication between stakeholders, enables rapid response, promotes asset efficiency, reduces costs, and increases company revenues [13].

The linear supply chain is transformed into digital supply networks (DSNs). The use of digital technologies such as Industry 4.0, Internet of Things, artificial intelligence, blockchain, logistics 4.0, robotics [11], and 5G allows for more responsive solutions to current problems and future predictions. Based on an analysis of best practices in global supply chain management, the following significant trends during the pandemic are identified:

- 1) anticipation of an economic downturn, which is manifested in need to find alternative sources of raw material supply, as well as doubts about whether the supply chain is too lean or whether it is worth continuing to use lean management in operations in such unstable conditions [14];
- 2) 'simple' steps to improve the efficiency of supply chains in many cases have already been exhausted. Further improvement may involve complete reconstruction of a network, radical simplification and elimination of links of a chain of deliveries that do not contribute in full to the creation of value [15];
- 3) The importance of digital tools for supply chain coherence is increasing.

1.2 Problem statement

Studies of supply chain management trends in the COVID-induced crisis have been conducted mainly in developed countries. Thus, the question remains whether these practices and trends are different in developing countries. The Russian Federation, the Republic of Azerbaijan, and the Republic of Kazakhstan, which are very different in terms of religion, geographic location, and size, are chosen for the study. This choice makes it possible to summarize general trends and develop recommendations for implementing the world's best practices in this group of countries.

The introduction of digital technology affects the enterprise's overall performance and transforms individual business models. Digital transformation can be a strategic initiative with a clear vision and new business opportunities. The study aims to examine the main digital tools used by small and medium local enterprises (SMEs)

and assess the prospects for logistics management development with the help of the latest technologies.

The research hypothesis is that SMEs that do not use digital tools are characterized by a low level of supply chain management. The criterion of processes standardization was chosen as a criterion of supply chain management quality as it corresponds to the best global practices.

Research objectives:

- interview residents of the selected countries and identify actual supply chain management practices during the COVID-19 crisis;
- identify common trends and differences in these countries;
- develop recommendations for implementing global best practices in this group of countries.

Respondents were selected from three countries – the Russian Federation, the Republic of Azerbaijan, and the Republic of Kazakhstan. This choice is explained by the fact that the countries have common features as post-socialist developing countries, making it possible to assess their differences (prevailing religion, geographical location, size) and develop recommendations for implementing best global practices.

2 Methodology

The study was conducted in several stages. The *first phase* of the study involved an online survey of managers at various levels of supply chain management in manufacturing companies and logistics operators. The purpose of the survey was to obtain empirical data on what digital technologies were used in supply chain management using Google forms.

Respondents were selected randomly. An invitation to take the survey was sent to those managers who stated Russia, Azerbaijan, or Kazakhstan as their place of residence in their Facebook profile. The survey was conducted between June and August 2021. From each country, 300 people from different industries participated in the study. The general characteristics of respondents are presented in Table 1.

Table 1 The number of SMEs involved in the study from each country

Sphere of activity	Russian Federation	Republic of Azerbaijan	Republic of Kazakhstan
Agriculture	18	12	19
Industry	21	25	24
Trade	58	73	81
Transport	41	17	25
Food industry	42	44	35
Information and telecommunications	24	28	29
Finance and insurance	33	28	33
Education and services	38	48	35
Medicine	25	25	19
Total	300	300	300

The study's limitation is the possible inconsistency of actual and official data. The questionnaire asked the following several questions (a maximum number of points received equalled 20):

1. Does the organization have a website? Does it work effectively? Yes, it works effectively (the chain 'view-select-box-payment' works) – 1; Yes, it works ineffectively – 0.5; No – 0.
2. Does search SEO-optimization of the firm's website exist? Yes – 1; Partly (with the help of professionals) – 0.67; Yes, independently – 0.33; No – 0.
3. Evaluate the effectiveness of information campaigns in social networks (not including advertising)? – Yes, we have a business page on Facebook and Instagram; a marketing person works effectively – 1; Yes, we run a business page; we work independently and successfully – 0.8; The pages are operating without a plan – 0.6; The webpages are very rarely updated – 0.4; There is a page, but it is not managed – 0.2; No page – 0.
4. Do you do informative business-related activities on other social networks (Telegram, YouTube, LinkedIn, Twitter, etc.)? Yes – 1; No – 0.
5. Do you use Facebook or Instagram ads, and are you satisfied with the results? Yes, we are satisfied with the results – 1; Yes, but we are not satisfied with the results – 0.67; Yes, we use ads very rarely, and we are not satisfied with the results – 0.33; No, we do not use Facebook/Instagram ads – 0.
6. Do you use advertising in Google Ads (Google AdWords)? Are you satisfied with the results? Yes, we use Google manager and are satisfied with the results – 1; Yes, we do it independently and are satisfied with the results – 0.67; Yes, we do it independently, but we are not satisfied with the results – 0.33; No – 0.
7. Do you use analytical tools (e.g. Google Analytics or another program)? Yes, we use Google Analytics, and we use this information – 1; Yes, but we do not use the results – 0.5; No, we do not use Google Analytics (we use another analytics tool – 0.
8. Do you use a program for resource planning? Yes, we use our ERP system – 1; No, we do not use such programs. We save information in Excel or another program – 0.5; No, we do not use any resource planning system – 0.
9. Do you use specialized financial and strategic management systems (budgeting, planning, consolidation, profitability)? Yes, we use 1C or another system – 1; No, we use only Excel spreadsheets - 0.5; No, we manage everything manually - 0.
10. Do you use a CRM system? Yes – 1; No, we use Excel spreadsheets or another system – 0.
11. What digital tools do you use to communicate with your staff (for surveys and information sharing)? Email/CRM/internal chat – 1; Viber/Skype/Telegram - 0.5; We communicate orally in person in the office or by phone – 0.
12. Do you use digital systems (online programs, manipulators, stimulators) for staff training? Yes, we use an electronic platform for training – 1; No, we teach without digital tools – 0.5; No, we do not do training at all – 0.
13. How do you communicate (get feedback, retain, stimulate a new purchase) with the customer? QR/social media/chat-bot – 1; Feedback on the website/email – 0.5; Personally/phone/in the office – 0.
14. Do you use specialized analytical applications for supply chain management (SCM systems and PDM (Product Data Management)? Yes – 1; No – 0.
15. Do you use a specialized BPM system? Yes, we use a BPM system – 1; No, we do not use a BPM system – 0.
16. Do you use advanced specialized tools for intelligent business analytics – Data Mining, Big Data, Business Intelligence, integration, consolidation, etc.? Yes, we use Data Mining technologies (our developments) – 1; Yes, we use various services (queries, reports, analytical tools: OLAP, Dashboards, production reporting, etc.) – 0.5; No, we do not use any analytical tools – 0.
17. Specify the ways of storing and maintaining your data. If you use several approaches, indicate them in the 'Other' option. Cloud technology and backups – 1; Excel spreadsheets (Google docs on Google drive) – 0.5; Ordinary files on computers – 0.
18. Is it possible to purchase (order) your service or its component (consultation, reservation, etc.) via the Internet, and what percentage of sales are covered by Internet sales? Yes, more than 90% of sales are performed online – 1; Yes, more than 50% of sales are done online – 0.8; Yes, 10% to 50% of sales are performed online – 0.6; Up to 10% of sales are performed online – 0.4; Less than 1% of sales are performed online – 0.2; No services/products are sold online – 0.
19. Do you use highly-specialized geographic information systems, area modelling, 3D printing, product location tracking, etc.? Yes, we use several highly specialized technologies – 1; Yes, we partially use such technologies – 0.5; No, we do not use any such technologies – 0.

Companies were divided into five groups based on the number of received points: 0-4 points (group 1), 4-11 points (group 2), 11-14 points (group 3), 14-18 points (group 4), 18-20 points (group 5). The decision to have five groups made it possible to identify all the necessary categories of digital maturity of business structures:

- companies with no experience in using digital tools;
- companies that only use social networks;
- companies partially using SMM, SEO and analytics;
- companies using professional services;
- leading companies that actively use analytics and specialized applications.

In the *study's second phase*, these same respondents were asked about their supply chain management practices. In the *third phase* of the study, recommendations were developed for each group on how to implement digital tools in supply chain management.

3 Results and discussion

The results of the *study's first stage* in the Russian Federation, the Republic of Azerbaijan, and the Republic of Kazakhstan are presented in Table 2.

Table 2 The percentage of respondents in each group of enterprises

Group / Percentage of enterprises	Russian Federation	Republic of Azerbaijan	Republic of Kazakhstan
1	10%	7%	11%
2	27%	49%	38%
3	43%	35%	37%
4	14%	7%	11%
5	6%	2%	3%

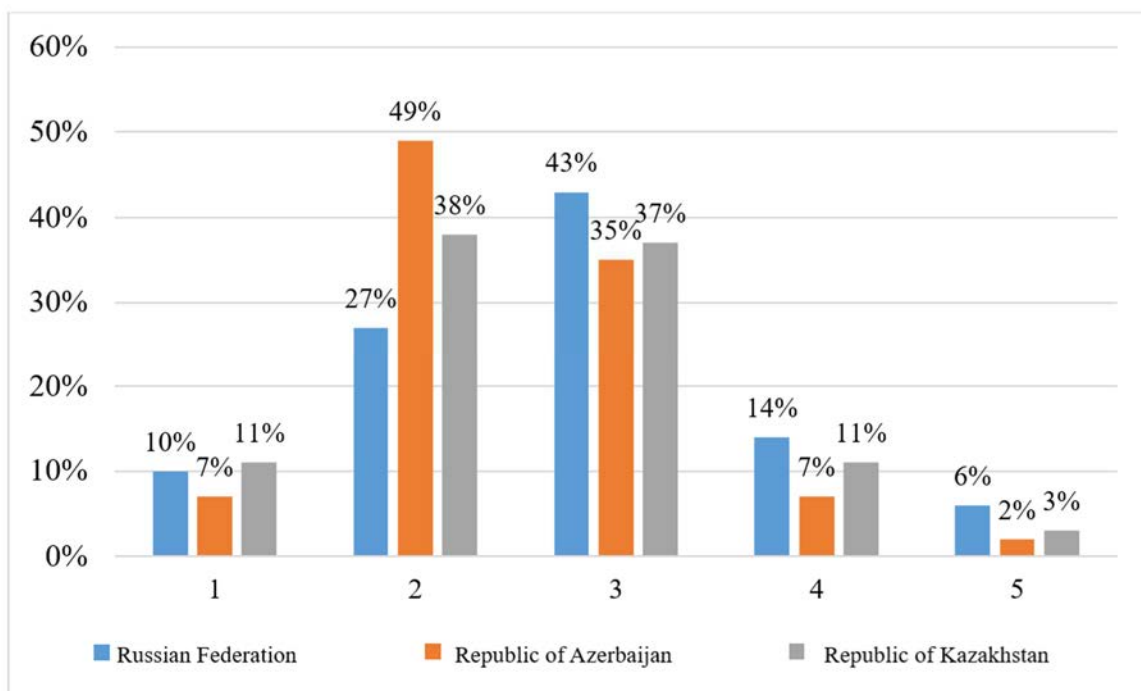


Figure 1 Percentage of enterprises in each group by country

There are similar trends in the distribution of the number of respondents in each group for all three countries. The maximum number of respondents is in groups 2 and 3 (Figure 1). Group 2 is characterized by the absence of purchase chain functioning on the website, complex digital and supply chain management tools. Social media is the only available tool. Group 3 is characterized by effective functioning of the website and the buying chain, active use of most digital tools (including advertising), absence of supply chain management tools, and the presence of a marketer who promotes a brand or product.

Respondents in groups 4 and 5 are the least numerous. Group 4 is characterized by a company's presence on the Internet, the use of simple tools partially or independently (SEO, social networks, advertising). Enterprises in group 5 use almost all advanced digital technologies, including the Data Science method.

In the *study's second phase*, the same respondents were surveyed about their supply chain management practices. A high proportion of respondents (55%, 60%, 55% in Russia, Azerbaijan, and Kazakhstan, respectively) working in markets in other countries confirm the increased awareness in this area and understanding of the importance of standardizing supply chain processes. Those entering or planning to enter international markets (50%, 35%, 33% in Russia, Azerbaijan, and Kazakhstan, respectively) are motivated to adopt European standards in their operations and be part of a responsible supply chain. Table 3 shows the survey results showing the extent to which supply chain processes are standardized. Respondents could choose several answers. Figure 2 shows the distribution of enterprises by the level of standardization of the supply management process in their activities.

Table 3 The level of standardization of the supply management process in enterprises' activities

Indicator	Russia	Azerbaijan	Kazakhstan
The process of selecting suppliers by criteria of interest to the manufacturer	27%	30%	32%
The supply planning process for materials and components	30%	27%	32%
Formation of inventories for individual product groups	28%	29%	27%
Supply consolidation process	24%	25%	24%
Supply Integrity Analysis	14%	13%	15%

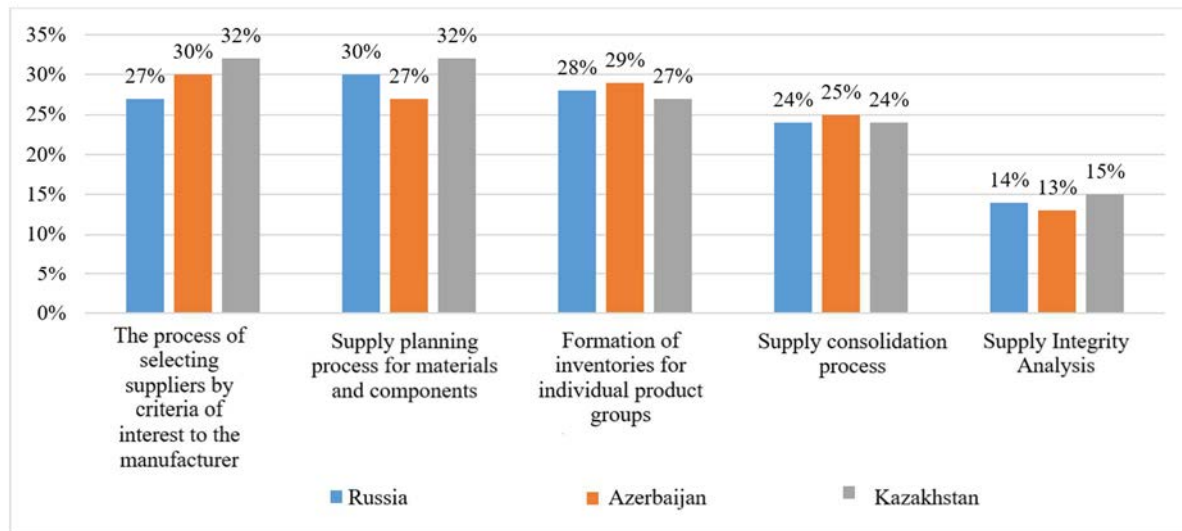


Figure 2 The level of standardization of the supply management process in enterprises' activities

The survey results were summarized into five groups according to the number of processes used (one process - one score). The results are presented in Table 4.

Table 4 Percentage of matching respondents in the groups based on the first and second phases of the study

Groups	Russia	Azerbaijan	Kazakhstan
Group 1	80%	77%	72%
Group 2	67%	65%	63%
Group 3	55%	50%	50%
Group 4	45%	45%	40%
Group 5	50%	50%	55%

A direct correlation confirms the research hypothesis that poor supply chain management is typical for small and medium-sized businesses that do not use digital tools. The results show the degree of standardization of supply chain processes. The highest number of applied standards is observed for the following processes: planning of material and component supplies; formation of inventories for certain product assortment groups; selecting suppliers by criteria of interest to the manufacturer.

The survey allowed the authors to identify the processes that need to be standardized first:

- implementation of the code of conduct for suppliers;
- selection of suppliers according to the criteria of interest to the manufacturer;
- consolidation of supplies.

Only one-third of respondents are motivated to implement the principles of standardization. These respondents belong to enterprises operating mainly in foreign markets.

Standardization of supplier selection can be represented through the following components:

- market analysis and selection of vendors' offers based on price and environmental 'friendliness' of the product (service);
- analysis of potential applicants according to other parameters of cost-effectiveness;
- ranking suppliers by a composite index, defined as a weighted average assessment of the supplier by selected criteria.

Table 5 presents the summary of processes, which should be standardized according to the respondents.

In the *third phase* of the study, recommendations were developed for each group on how to implement digital tools in supply chain management (Figure 3).

Group 1 should implement the following measures:

- basic digital skills for all employees;
- development of professional skills of employees who work directly with digital technologies;
- use of essential digital tools, such as social networks, messengers, online documents, design platforms;
- providing employees with the required amount of digital technology.

Recommendations for group 2 include:

- basic digital skills of all employees in the enterprise and developing the professional skills of employees who work directly with digital technologies;
- create the position of SMM manager/internet marketer/specialist in digital technology after increasing the presence on social networks and other platforms;

- transition to more sophisticated use of social networks, regular content creation, automation of communication with clients through chatbots, QR-codes, etc.;
- having the necessary amount of technology and keeping it up to date.

Table 5 Processes to be standardized in supply management

Indicator	Russia	Azerbaijan	Kazakhstan
The process of selecting suppliers by criteria of interest to the manufacturer	33%	35%	34%
Grid model development of supply processes	28%	27%	28%
Material supply planning	12%	14%	13%
Consolidation of supplies	29%	32%	30%
Introduction of a code of conduct for suppliers	10%	11%	5%
Selection of inventory method for product assortment groups	21%	22%	25%

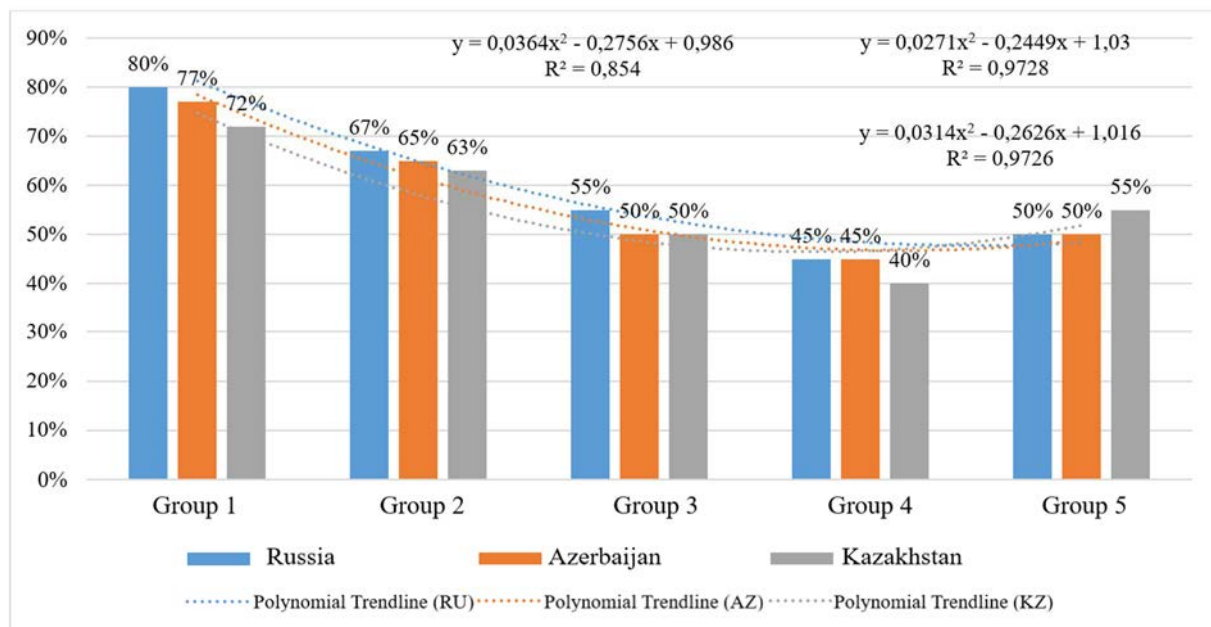


Figure 3 Percentage of matched respondents in groups based on the first and second stage

The enterprises in group 3 should take the following measures:

- conduct an external audit of the quality digital tools used by the enterprise and consult with professionals in the field, if necessary;
- follow trends in the industry, attend conferences, and adopt the experience of competitors and trendsetters;
- create a strategy for positioning the company in the online space,
- use data analytics for decision making and specialized systems for complete automation of business processes;
- use statistical analytics and forecasting technologies, industrial robots, sensors, etc., if necessary;
- keep technology and software up-to-date.

Businesses in group 4 should take the following measures:

- create a position of SMM-manager/internet-marketer, etc.

- analyze trends in the industry, adopt the experience of competitors or brands from related businesses, consult with professionals on the problems and opportunities for the use of a particular digital tool;

- position the company on social networks, create regular content, and publish it according to the content plan, use advertising campaigns on social networks;
- introduce automatic communication with clients using chatbots, QR codes, etc., carry out SEO optimization of the website;
- use CRM systems, financial management systems, connect analytical tools to data collection;
- keeping technology and software up to date.

The enterprises of group 5 should continue the professional development of company specialists and attend highly specialized conferences, events, courses, and webinars.

Analysis of the list of specific recommendations developed to increase ownership of digital tools in supply chain management for different groups of SMEs showed that most proposals aim to improve the digital literacy of company employees and increase the share of digital tools used. Practice shows that digital tools are rarely used in supply chain management, and companies do not have specialized software.

On the other hand, the problem is complex since the standardization system provides digital tools for supply chain management [16]. Thus, the digitalization of SMEs in the studied countries is quite difficult. It should be noted that the low level of digital technologies application leads to poor business processes [17]. One of the critical implications for enterprise management is focusing on interactions with all counterparties, not just internal processes.

With the easing of quarantine restrictions, most companies wholly or partially returned or will return to the usual mode of work in the office. Researchers notice that many managers have changed their position regarding remote work. They prefer a remote form of work due to the growth of efficiency indicators [12]. New technological solutions, the development of new products and services, finding new suppliers or selling through new sales channels will be a nice bonus and income for organizations after the pandemic. Thus, business models will be divided into the ones operating before and after the pandemic. The main supply chain management strategies in this area will be focused on resilience [18,19]. Other strategies will be aimed at reducing supply chain losses [20]. However, in general, all researchers agree that companies will face total digitalization [21,22].

Digitalization of business is not only an anti-crisis tool but also a common way to increase company revenues. Those who make maximum efforts during the crisis to win their audience with quality services and reasonable prices win [23]. The global business trend shows that the annual growth of online retailing was about 20% over the past five years, while offline growth was only 3.5% [24]. In a few decades, online commerce will be the main channel for the sale of goods, and offline will be relegated to the background. In this new environment, companies must not only learn how to digitize their business but also be able to manage their activities with the help of various modern, practical anti-crisis tools.

Before the pandemic, globalization was the prevailing trend. Digitalization will increase the globalization of all markets, which will affect the organizational culture of companies. New requirements for digital culture and tools will include [25]:

- the ability to produce and use digital technology;
- increased requirements for hard-skilled personnel;
- access to hardware and software products;
- the importance of systems integration of software products;
- the ability to act out of the box and generate ideas.

The actions of those enterprises that demonstrate the understanding of digital transformation importance can be divided into four steps:

1. Investments in the latest digital tools are often chaotic and unsystematic due to the lack of a systematic policy in this area;
2. Investment in the Internet of things;
3. Digital tools training for staff, development of monitoring systems and logistics;
4. Develop an effective digitalization strategy and implement its main provisions in practice.

4 Conclusions

The article discusses the practice of using digital tools by small and medium-sized enterprises (SMEs). A survey of companies' employees in the Russian Federation, the Republic of Kazakhstan, and the Republic of Azerbaijan was conducted to confirm that SMEs that do not use digital tools in supply chain management are also characterized by poor supply chain management. The selected criterion of processes standardization was quality supply chain management, which corresponds to the best international practices.

The study found that the level of digital tools and specialized software used in supply chain management in Russia, Azerbaijan, and Kazakhstan is low. Most of the supply management processes are chaotic and non-standardized. The following processes are the most standardized: planning the materials and components supply; forming inventories for individual product assortment groups; selecting suppliers according to the criteria of interest to the manufacturer. The survey found that the respondents understand the importance of the processes and plan to use digital tools in the future. Most motivated to introduce the best practices of supply management are employees of companies operating in foreign markets. Further research is going to be focused on the implementation of digital tools.

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To stay or not to stay: the mediation roles of job satisfaction and organization commitment among women in logistics industry

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Abstract: The logistics sector is considered non-traditional for women as the industry employs mostly men as the required tasks are considered masculine. Logistics operation runs 24/7, which leads to long working hours and overlaps with women's household responsibilities. The situation is linked to turnover intention among women in this industry. Numerous studies have acknowledged women to be as good as men. Therefore, turnover among women in this industry is a significant loss for the industry as gender imbalance remains a major issue. Furthermore, studies on this subject remain scarce. This study addressed the literature gap by adopting the Self Determination Theory (SDT) and investigated the factors influencing female employees' intention to stay in the logistics industry. Data analysis was performed using a purposive sampling technique and Smart Partial Least Squares (Smart PLS). Resultantly, job satisfaction mediated the relationship between intrinsic motivation and intention to stay but did not mediate extrinsic motivation and intention to stay. Additionally, the relationship between work-life balance and intention to stay was mediated by organisational commitment. The findings benefit human resource management in the logistics industry to design a better policy to reduce retention prevalence and decrease the number of talented female employees leaving this industry.

1 Introduction

The transportation and logistics sectors are unconventional among women as these industries primarily employ men, which entails 'masculine' tasks. Previously, the transport and logistics industry (particularly shipping) was viewed as male-dominated without any job opportunities for females. The global trend highlights women's underrepresentation in the transportation and logistics sector throughout Asia and the Pacific [1]. Hence, inequity and career obstacles remain an issue in the sector.

The complexities experienced by working mothers in the transport and logistics sectors are caused by working hours (such as in multinational companies), which clash with their family commitments. Increased working hours and related work stress can affect the amount and quality of time with family [2]. Balancing between work and family life is becoming increasingly challenging as many employers demand employees to work longer hours and perform more demanding workloads, which forces trade-offs from numerous employees, mainly working women worldwide [3]. Although the pressure on women to work long hours negatively impacts their family life, women must accept the reality by making the appropriate adjustments [4].

The main challenge women encounter in the sector concerns balancing professional and family life within societal expectations [1]. In most culturally strict patriarchal countries, women are expected to spend more time with their families. Working in the transportation and logistics industry usually necessitates extended business trips and participation in several networking events in male-dominated environments. Surveys emphasised these "outside-the-office activities" as the main inconvenience among women.

Society perceives that woman should not work in dangerous and unclean areas, such as logistics. The logistics sector has traditionally been associated with physical work and is dominated by men [5]. Nevertheless, advancements in logistics technology have increased employment opportunities for women while specific technological advancements continue to reduce incorrect perceptions that certain job roles are too dangerous or impractical for women. The logistics and transportation sector gradually gained traction in becoming one of the primary sources of employment, hence the subject is crucial.

Female professionals experience greater challenges at work and home, thus increased pressures at work could affect family commitments [6]. Women are assigned to certain home duties, which they must fulfil as mothers, wives, and daughters-in-law [7] which is directly

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associated with turnover intent. Excessive work hours and workload in the logistics sector will compete with family commitments as multinational supply chains require regular round-the-clock assistance including on weekends and holiday [8]. For instance, increased work hours and related working conditions may influence the amount and quality of relationships between family members.

Based on, [9] female employees' turnover rates were higher in the workforce, while the medical field recorded high turnover rates among female nursing staff in China [10]. Studies on the factors of female employee turnover rate outlined an increase among female workers who quit. Other studies highlighted factors influencing turnover intention among female nurses working on shifts in the medical sector, such as high work pressure and work-family conflict [11]. Thus, insufficient empirical research exists on female workforce retention in Supply Chain Management (SCM) to resolve the talent shortage [12].

The number of female employees in the workforce is at a reasonable rate. A low percentage of women employees is as good as males in their competencies [13]. For instance, women in the logistics industry (SCM) represent 35% of the workforce [14]. Notably, 38% of the labour force comprises women, while 19% of the management positions in port operations are held by women (Study Survey, 2016). The Ministry of Women, Family, and Community (2016) in Malaysia reported that women accounted for 1.5% to 2% of the maritime logistics industry [15]. The current study investigated why female employees continue to be interested in working in the logistics industry despite the issues. These factors that influence women workers' intention to stay in the Malaysian logistics sector were examined.

Human Resource Management (HRM) in the logistics industry should retain the number of women who work in logistics. Due to globalisation, the development and implementation of conventional HRM strategies and processes are insufficient to sustain trained staff in the present dynamic work environment [16]. The logistics company must reveal the factors influencing women's commitment towards the industry. This study also benefits logistics industries that encounter various turnover issues. Additionally, the current study presented a foundation to retain or reduce turnover among women employees in the logistics field.

2 Literature review

2.1 Self-Determination Theory

The Self-Determination Theory (SDT) was created by [17]. This theory explains that workers' motivation for professional activities impacts their performance and well-being. The SDT has been applied in various fields involving multiple employees, such as public employees [18,19] in the performance of green supply chain management [20], job satisfaction among hotel housekeepers [21], and the intention to stay among employees in the construction industry [22]. This study

applied SDT to determine whether intrinsic or extrinsic factors influence women's satisfaction and desire to remain in the logistics sector.

2.2 Intention to stay

Intention to stay was defined by [23] as an individual's work evaluation upon entering the work domain and interacting with the working environment, the identity to continually participate in specific organisational goals, and the identity and willingness to remain in the original work position. In this study, the intention to stay denotes a person's dedication towards their work and willingness to remain employed.

Studies in various areas have examined the intention to stay, which includes all types of employees, such as public employees [24] and care workers in the care service [25]. In the medical field, emergency nurses in Shanghai [26] were examined to determine the elements that affect their intention to stay. Past research emphasised a lack of empirical data on the intention to stay or commit, specifically among women in the logistics industry. This study investigated the reasons underpinning female employees' interest in working in the logistics industry despite the complexities of doing so. The intention to stay was the dependent variable that identified the factors affecting women employees' survival in logistics.

2.3 Intrinsic

Intrinsic motivation is the most individualistic type of motivation, which refers to engaging in an activity for the pleasure and fulfilment obtained from participation. The study defined intrinsic motivation as accomplishing something without anticipating a fair value. Employees work diligently when they are satisfied with their work and environment. Furthermore, employees can be intrinsically motivated by at least parts of their jobs (if not all) and tend to display high-quality performance and wellness when intrinsically motivated [27].

A study on the hotel industry outlined a positive relationship between intrinsic factors and job satisfaction among hotel housekeepers [28]. An interesting and useful job to society has a higher intrinsic factor among hotel housekeepers, which results in job satisfaction. A significant relationship was identified between intrinsic motivation and job satisfaction among electricity employees in Vietnam [29]. Hence, the following hypothesis was proposed:

H1: Intrinsic motivation has a positive relationship with job satisfaction.

2.4 Extrinsic

In works that are less intrinsically satisfying with incentives directly tied to performance or results, such as bonuses and commissions, employees tend to consider money as the major reason for completing the task where extrinsic motivation will likely continue [30]. In this study,

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extrinsic motivation occurs when employees are rewarded for their hard work to encourage job satisfaction in their company. Extrinsic motivation is often differentiated from intrinsic motivation, which concerns behaviours performed for reasons outside their inherent satisfaction.

Extrinsic motivation among retail workers positively influenced job satisfaction [31]. In 2019, a study [21] examined the determinants of extrinsic motivation across occupations and revealed a positive relationship between employees' extrinsic motivation and job satisfaction. Extrinsic motivation has become essential in achieving higher job satisfaction in the hotel industry based on its positive effect on hotel housekeepers [28]. In the study [29] among electricity employees, extrinsic motivation positively impacted job satisfaction. Therefore, the current study presents the following hypothesis:

H2: Extrinsic motivation has a positive relationship with job satisfaction

2.6 Work-life balance

Work-life balance denotes how individuals can manage and overcome work and family conflicts to achieve balance [32]. Work-life balance occurs when an individual feels similar participation and satisfaction in the work domain and family with little conflict due to their capacity to manage various duties and establish priorities [33]. A positive work-life balance could boost morale, productivity, and organisational commitment, and minimise absenteeism [34].

Work-life balance is positively related to organisational commitment among employees from various public and private sector organisations across Pakistan [35]. Subsequently, the research [36] suggested that many university teachers perceived a positive impact of work-life balance on the level of commitment towards their organisation. In this study, women in the logistics industry may encounter more work and family issues. Increased demands at work could influence family responsibilities [6]. Employees that appreciate work-life balance will be more committed to their organisation [37]. An improved work-life balance would increase employee commitment, as suggested in the hypothesis below:

H3: Work-life balance of women in logistics industry has a positive relationship on organization commitment.

2.5 Job satisfaction

According to [38], Job satisfaction involves the physiological and psychological well-being of employees. The attention on the psychology and requirements of employees would alter their behaviour and increase their productivity. Successful organisations prioritise employee job happiness over customer satisfaction, recognising that satisfied employees will produce higher-quality goods, achieve and maintain high work productivity, and remain loyal to the organisation [22]. This study defines job satisfaction as women employees' level of job satisfaction

and commitment to continue working in the logistics industry.

Satisfied employees will be motivated to perform better and stay longer in the organisation [39]. Employees will quit if their job satisfaction levels are continuously low. A study in the medical field [40] used job satisfaction as one of the variables that demonstrated a positive relationship towards the intention to stay. Other studies discovered that most nurses were satisfied with their jobs (75%) and did not intend to leave their current position [41]. A significant positive relationship was highlighted between job satisfaction and intention to stay among government employees in Qatar [42]. Thus, the study presented the following hypothesis:

H4: Job satisfaction has a positive relationship with the intention to stay.

2.7 Organization commitment

The three distinct types of organisational commitment are emotional commitment, continuation commitment, and normative commitment [43]. Affective commitment refers to the employee's emotional attachment and willingness to work for the organisation. The literature emphasised that satisfied employees tend to stay with their organisation. This study proposed that employees tend to leave their organisation when no new opportunities are available in their current field and a low level of job commitment [44]. Summarily, women in the logistics industry who are more committed to their jobs tend to be more motivated to stay in the existing organisation.

Numerous studies have revealed a significant relationship between organisational commitment and turnover intention (intention to commit). Employees with high organisational commitment intend to stay in the establishment [43]. A research [42], discovered a positive relationship between industry commitment and intention to stay as a government employee in Qatar. The following hypothesis was proposed based on the aforementioned discussions:

H5: Organization commitment of women in logistics has a positive relationship with intention to stay.

2.8 Mediation

Mediation analysis is commonly used to signify the theoretical contribution to the social science field [45], [46]. A mediating variable is a variable or strategy that mediates the influence of an antecedent variable on an outcome [47]. The mediator serves as a third variable that describes how the independent variable of interest affects the dependent variable [48,49].

Past discussions outlined a consistency in the relationship between intrinsic motivation and job satisfaction [22,28,29]. A consistent positive relationship was discovered between extrinsic motivation and job satisfaction [21,28,29,31]. Various studies also noted a consistent positive relationship between job satisfaction

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and the intention to stay [40,42]. Therefore, this study suggested that job satisfaction mediates the relationship between intrinsic motivation and the intention to stay, extrinsic motivation, and the intention to stay. The following hypotheses are presented:

H6: Job satisfaction mediates the relationship between intrinsic motivation and the intention to stay.

H7: Job satisfaction mediates the relationship between extrinsic motivation and the intention to stay.

Past studies also highlighted a consistent relationship between work-life balance and organisational commitment [35,36,50]. Previous research has indicated a consistent positive relationship between organisational commitment and intention to stay [42]. Therefore, the current study proposed that the relationship between work-life balance and intention to stay is mediated by organisational commitment:

H8: Organization commitment mediates the relationship between work-life balance and intention to stay.

3 Methodology

A quantitative methodology was employed to evaluate the assumptions and achieve its purpose. The unit of analysis was individuals and the most appropriate research instrument was a self-administered survey questionnaire [51]. The study population was women in the logistics industry currently working at a logistics company in Malaysia. All respondents participated voluntarily to ensure result accuracy. A non-probability purposive sampling method was deemed the most suitable considering that the total population was unidentified and the analysis was aimed at evaluating the theoretical effect [52,53]. A total of 248 data were gathered from the self-administered questionnaires.

This study employed structural equation modelling using SmartPLS for hypothesis development. In applying this approach for data analysis, the sample size should be established by the power of analysis, which is the minimal number of samples required based on the complexity of the model [53,54]. Additionally, a medium effect size with a power of 0.8 is suitable to identify a sufficient number of respondents in the social science field [55]. A study with 3 predictors and a medium effect size requires at least 76 respondents [56]. The current study respondents were 248, thus fulfilling the minimal sample size requirement.

4 Analysis and Findings

For data analysis, 248 questionnaire sets were used. Most respondents were between 26 and 33 years old

(39.1%). Additionally, 71.4% of the respondents were single women. A majority of the respondents (61.3%) possessed a bachelor's degree. As for ethnicity, a majority of the women were Malay (80.6%). In terms of income level, the highest income level was between RM 1,000 and RM 3,000 (50% of the respondents). The respondents mainly had 1 to 3 years of working experience (46.8%).

4.1 Common method bias

The study aimed to identify a predictive function and an appropriate application of the Smart PLS software [54]. Using a single data source may result in a common method variance, which affects the quality of the findings [57,58]. The procedural and statistical methods of analysis were applied to address this issue. Hence, this study employed a different anchor scale to measure the constructs for the procedural method [45,59] with full- collinearity analysis [60]. A seven-point Likert scale was used to assess the intention to stay, while a five-point Likert scale measured the other constructs. A VIF value of under or equal to 3.3 indicates no bias in a single data source. The analysis revealed that the VIF values were under 3.3, thus indicating that the CMV was not a severe issue in the study. Table 1 summarises the complete collinearity testing for each construct.

Table 1 Full collinearity testing

EXT	INS	JS	WLB	OC
1.121	2.120	2.259	1.409	2.321

4.2 Measurement model

The analysis followed a two-step approach [54], which are the measurement and structural models. Regarding the measurement model, convergent and discriminant validity must be established before continuing with the structural model. Convergent validity is a test determining whether the items used to measure the same construct as validated by [45]. The loading must be ≥ 0.5 , the average variance extracted (AVE) should be ≥ 0.5 , and the composite reliability ≥ 0.7 to establish the convergent validity [61]. Table 2 highlights the convergent validity results. The heterotrait–monotrait ratio of correlations (HTMT) is used to establish the discriminant validity [61]. In Table 3, all HTMT values were under 0.85, thus indicating discriminant validity [62].

[63] recommended that the heterotrait–monotrait ratio of the correlations (HTMT) be used for establish the discriminant validity, As shown in Table 3, all HTMT values were less than 0.85, indicating that the discriminant validity was establish.

Table 2 Convergent validity

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	<i>Items</i>	<i>Loading</i>	<i>CR</i>	<i>AVE</i>
<i>Extrinsic</i>	<i>EXT1</i>	0.739	0.882	0.655
	<i>EXT2</i>	0.938		
	<i>EXT3</i>	0.832		
	<i>EXT4</i>	0.707		
<i>Intrinsic</i>	<i>INS1</i>	0.589	0.893	0.584
	<i>INS2</i>	0.792		
	<i>INS3</i>	0.822		
	<i>INS4</i>	0.827		
	<i>INS5</i>	0.828		
	<i>INS6</i>	0.696		
<i>Intention to Stay</i>	<i>ITS1</i>	0.934	0.954	0.873
	<i>ITS2</i>	0.925		
	<i>ITS3</i>	0.943		
<i>Job Satisfaction</i>	<i>JS1</i>	0.915	0.917	0.786
	<i>JS2</i>	0.879		
	<i>JS3</i>	0.866		
<i>Organization Commitment</i>	<i>OC1</i>	0.858	0.938	0.751
	<i>OC2</i>	0.824		
	<i>OC3</i>	0.915		
	<i>OC4</i>	0.890		
	<i>OC5</i>	0.843		
<i>Work-life Balance</i>	<i>WLB1</i>	0.856	0.875	0.701
	<i>WLB2</i>	0.882		
	<i>WLB3</i>	0.769		

Table 3 Discriminant Validity (HTMT)

	EXT	ITS	INS	JS	OC	WLB
Extrinsic						
Intention to Stay	0.266					
Intrinsic	0.222	0.540				
Job Satisfaction	0.101	0.582	0.768			
Organization Commitment	0.276	0.742	0.641	0.643		
Work-life Balance	0.205	0.347	0.573	0.591	0.340	

4.3 Structural model

The structural model tested the hypotheses upon establishing the measurement model. A bootstrapping procedure [61] with 5,000 samples was used to assess the hypotheses developed based on the research model (see Figure 1). The hypotheses are supported if the beta value aligned with them with a t-value of ≥ 1.645 , a p-value of ≤ 0.05 , and no null values for the confidence interval between the lower level (LL) and the upper level (UL) [45].

The direct effect results indicated that only intrinsic motivation ($\beta = 0.673$, $p < 0.001$) was positively related to job satisfaction. Hence, H1 was supported. Nonetheless, extrinsic motivation ($\beta = -0.025$, $p < 0.337$) demonstrated an insignificant relationship with job satisfaction. Thus, H2 was unsupported. Job satisfaction ($\beta = 0.194$, $p < 0.005$) and organisational commitment ($\beta = 0.574$, $p < 0.001$) positively influenced the intention to stay. Hence, H3 and H4 were supported. The direct effect of work-life balance ($\beta = 0.292$, $p < 0.001$) also indicated a positive effect on organisational commitment, thus supporting H5.

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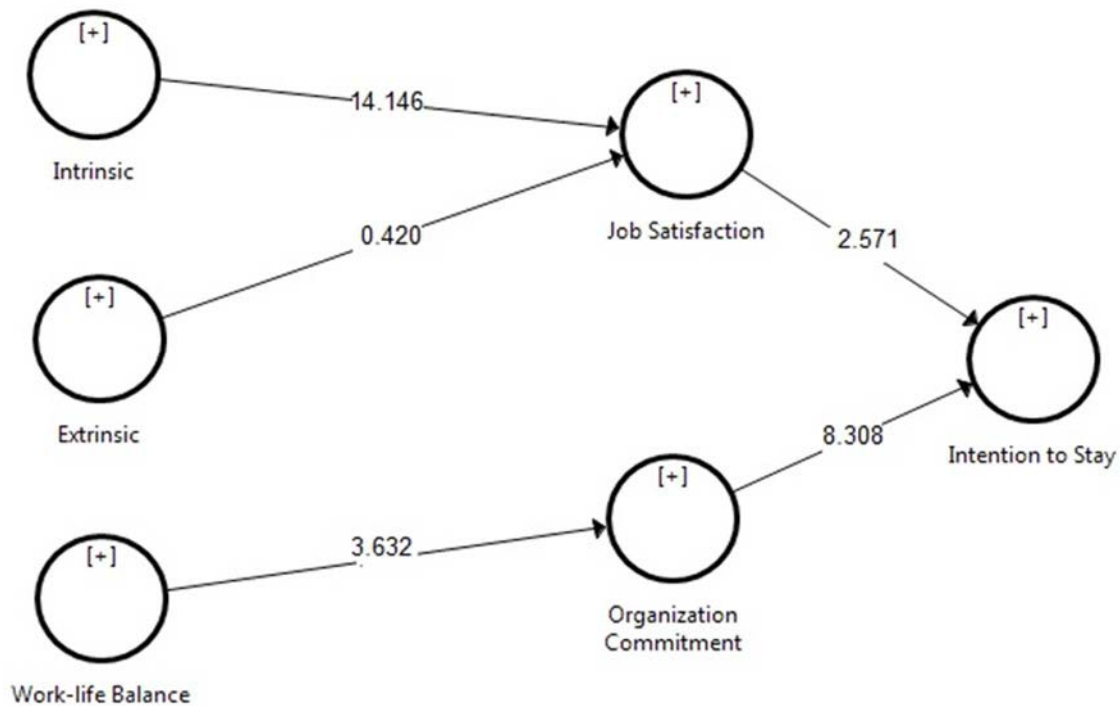


Figure 1 Structural model

Table 4 Hypothesis testing for direct effect

Hypothesis	Relationship	BETA	SE	t-value	p-value	LL	UL	Decision	VIF
H1	INS -> JS	0.673	0.048	14.146	0.000	0.587	0.742	Supported	1.042
H2	EXT -> JS	-0.025	0.060	0.420	0.337	-0.162	0.049	Unsupported	1.042
H3	JS -> ITS	0.194	0.075	2.571	0.005	0.084	0.333	Supported	1.488
H4	OC -> ITS	0.574	0.069	8.308	0.000	0.445	0.675	Supported	1.488
H5	WLB -> OC	0.292	0.080	3.632	0.000	0.151	0.412	Supported	1.000

The hypotheses for mediation are supported if the t-value of ≥ 1.96 , p-value of ≤ 0.05 , and no null values for the confidence interval between the LL and UL. The mediation analysis results are from H6 to H8. The guidelines [64] employed in this study indicated that LL and UL did not straddle a 0 in the middle, thus suggesting no mediation effect between the independent and dependent variables. The results in Table 6 demonstrated that $\beta = 0.130$, $p < 0.014$, $LL = 0.042$, and $UL = 0.253$ for the relationship between intrinsic motivation job satisfaction and intention to stay, therefore signifying that

job satisfaction mediated the relationship between intrinsic motivation and intention to stay. Hence, H6 was supported.

The indirect effect of extrinsic job satisfaction and intention to stay ($\beta = -0.005$, $p < 0.695$, $LL = -0.048$, and $UL = 0.010$) emphasised that job satisfaction failed to mediate the relationship between extrinsic motivation and the intention to stay (H7). The indirect effect on the relationship between work-life balance, organisational commitment, and intention to stay ($\beta = 0.168$, $p < 0.001$, $LL = 0.078$, and $UL = 0.258$) signified that organisational commitment mediated the relationship between work-life balance and intention to stay. Hence, H8 was supported.

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Table 5 Hypothesis testing for indirect effect

Hypothesis	Relationship	BETA	SE	t-value	p-value	LL	UL	Decision
H6	Intrinsic Satisfaction -> Intention to Stay	0.130	0.053	2.449	0.014	0.042	0.253	Supported
H7	Extrinsic Satisfaction -> Intention to Stay	-0.005	0.012	0.391	0.696	-0.048	0.010	Unsupported
H8	Work-life Balance -> Organization Commitment -> Intention to Stay	0.168	0.046	3.621	0.000	0.078	0.258	Supported

4.4 PLS predict

A study [65] proposed the use of PLS prediction. This holdout sample-based technique makes case-level predictions at the item or constructs level using the PLS Predict with a 10-fold procedure to evaluate predictive relevance. Strong predictive power is obtained when all item differences (PLS-LM) are below the predictive relevance, while moderate predictive power is determined

when most item differences are below the predictive relevance. Furthermore, a minority of the item with a lower value suggests a low predictive power [65]. Nevertheless, predictive power cannot be established if the differences between all items exceed the predictive relevance. In Table 5, the results indicated that a predictive power for intention to stay and organisational commitment was not established. Nonetheless, the results displayed a strong predictive power for job satisfaction.

Table 6 PLS predict

Items	PLS RMSE	LM RMSE	PLS-LM	Q ² predict	Decision
ITS1	1.027	1.008	0.018	0.155	Not Confirm
ITS3	1.057	1.021	0.035	0.119	
ITS2	1.029	1.018	0.011	0.099	
JS2	0.627	0.638	-0.011	0.300	Strong Predictive
JS3	0.709	0.712	-0.003	0.305	
JS1	0.557	0.571	-0.013	0.398	
OC2	0.763	0.730	0.033	0.060	Not Confirm
OC4	0.754	0.692	0.062	0.044	
OC1	0.754	0.711	0.042	0.027	
OC5	0.752	0.702	0.050	0.072	
OC3	0.708	0.636	0.072	0.044	

5 Discussion and conclusions

The results emphasised that intrinsic motivation significantly affects job satisfaction and influences women’s intentions to stay in the logistics industry. In relation to H1, intrinsic motivation was positively related to job satisfaction. The results were consistent with earlier studies [22,28,29] where intrinsic explained job satisfaction. The findings also indicated that women in logistics companies with intrinsic motivation tend to be satisfied, hence they intend to remain in their workforce. Employees who believe that their talents are being efficiently utilised indirectly influence their workplace satisfaction.

Extrinsic motivation and job satisfaction were not related (H2). Nevertheless, previous studies revealed that external motivations positively affected satisfaction. Interestingly, the studies discovered employees’ disinterest in external motivators, such as rewards, high pay, and

promotions. The literature underlined that external motivation is essential in determining their level of satisfaction, which occurred during a normal scenario. Nonetheless, the data were collected during the COVID-19 pandemic, which forced them to choose between economic stability or their health, which offered a new finding concerning this relationship. This scenario aligns with the new norm created by the pandemic, thus justifying the relationship between extrinsic motivation and job satisfaction. Moreover, limited job opportunities during the pandemic raised awareness among the women in logistics who are grateful for their jobs due to the number of jobless people due to the crisis.

The relationship between work-life balance was positively related to organisational commitment, thus supporting H3 in line with prior research [30,42]. A successful work-life balance can produce more dedicated and satisfied employees. Logistics companies must refrain

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from interrupting their employees after work hours and on off days to focus on their personal lives. Women, specifically homemakers, could concentrate on their chores, such as cooking and cleaning. This is the company initiative to assist employees in balancing their families with career life.

This study also explored the role of job satisfaction and organisational commitment in influencing the intention to stay among women in the logistics industry. Hypothesis 4 highlighted that job satisfaction is positively associated with the intention to stay among women in the logistics industry. Previous studies [40,42] also supported the relationship between job satisfaction and intention to stay. Satisfied employees are less likely to leave their current job [66]. Offering greater professional development options through diverse projects and new responsibilities and developing a reward system might enhance satisfaction among women in the industry.

The findings suggested that organisational commitment is positively associated with the intention to stay among women in the logistics industry. Employees with high organisational commitment intend to stay with the establishment [43,67]. Employees dedicated to their organisation have a more optimistic view of the companies and a stronger intention to stay, thus minimising turnover. The positive relationship between organisational commitment and intention to stay is generally supported in previous studies. The independent variable has a significant relationship with the intention to stay [42]. In this study, women in the logistics industry feel that their commitment to their position is important to consider and assist organisations achieve their goals. Consequently, their behaviour causes them to continue to commit to and stay in this industry.

Job satisfaction and organisational commitment act as a mediator in the relationship between intrinsic (H6), extrinsic (H7), and work-life balance (H8) in the intention to stay among women in the logistics industry. Nevertheless, only H6 and H8 were supported. Hence, job satisfaction mediates the relationship between intrinsic and extrinsic intention to stay. Job satisfaction has a mediating effect on the intrinsic intention to stay. The findings demonstrated that intrinsic motivation ensures women employees' satisfaction to remain in the logistics industry, thus supporting H6. Organisational commitment also mediated the relationship between work-life balance and intention to stay, hence supporting H8. The mediating role of organisational commitment established that women in the logistics sector who can successfully manage work and family life are more committed to their jobs and possess a higher intention to stay in the industry.

6 Theoretical and practical implication

The SDT constructs, intrinsic motivation, extrinsic motivation, work-life balance, job satisfaction, and organisational commitment provided valuable insights into women's intention to stay in the logistics industry. The

expanded SDT model contains theoretical and practical implications to predict women's desire to remain in the industry. This finding will benefit human resources, managers, and all logistics companies to maintain the number of women employees in the logistics industry.

In terms of theoretical implications, examining the intention to stay among women employees contributed to the existing knowledge of the subject [68,69]. The current study provided vital insight into women's intention to stay in the logistics industry. Studies have been conducted on the intention to stay. The results highlighted the expanded model as beneficial for predicting women's determination, which provided directions for future research to enhance the understanding of women's desire to stay.

Results of the direct effect show this study verified intrinsic motivation as variable influencing job satisfaction and work-life balance influencing organization commitment in the logistics industry for women. Only extrinsic motivation is not able to be influencing job satisfaction in this study. Consequently, the current study enhanced findings from prior studies on intrinsic motivation and job satisfaction [22,28] and studies on work-life balance influencing organization commitment [36,50]. The mediation analysis provided significant evidence of intrinsic motivation in shaping job satisfaction and influencing intention to stay. Moreover, significant evidence of work-life balance in shaping organization commitment influencing intention to stay, providing deeper insight into the determination of intention to stay towards women in the logistics industry. Extrinsic motivation is an insignificant factor to influencing intention to stay of women in the logistics industry, contrary to previous studies. The author encourages other scholars to study why this factor is irrelevant in the current setting. Future research could also provide a mediating component between this association, given that the current findings contradict previous research. The author invites other researchers to investigate why that factor is insignificant in the present context. Future studies could also introduce a mediating factor between that relationship since the findings contradict the literature.

The extended SDT model guides logistics company managers regarding the factors influencing their women employees' intrinsic motivation and job satisfaction. Women employees who are generally motivated as the work is interesting and desire to improve tend to persist longer. Managers could enhance intrinsic motivation by assisting women employees in recognising their improvement, receiving positive feedback concerning skill development, and discussing what was learned from the task. Effective work-life balance results in more engaged employees with lower levels of absenteeism, sickness, and stress, and raises the intention to stay in organisations. Logistics company employers must respect these women after working hours by not interrupting after work hours and on off days to focus on their personal lives. Women, such as, homemakers can focus on chores, such as cooking

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and cleaning. This is the organisational initiative to aid employees in balancing their families and careers.

7 Limitation and future studies

In order to broaden the applicability and transferability of the suggested model and increase its adaptability to other nations and cultures, the proposed model must be tested in different settings. Additionally, the questionnaire was designed to measure using the SDT variables and the factors influencing women's intention to stay in the logistics industry. Consequently, the model can be improved by examining women's intention to stay in the logistics industry based on several theoretical viewpoints. Social exchange theory can be employed for future research as it has not yet been implemented in examining Malaysian women in the logistics business. Future studies could also enhance this model by integrating the variables impacting women's intention to stay within the logistics industry, such as work-life conflict and personal job fit in various nations and cultures.

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Adaptation of logistics companies to operation under the Covid-19 pandemic restrictions

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Keywords: adaptation, pandemic, logistics company, digitalization, electronic logistics.

Abstract: The COVID-19 pandemic has made the problem of companies adapting to operate under restrictions more acute. Logistics companies were the special focus of researchers because of the specifics of the COVID-19 pandemic. The article aims to determine the features of the management of logistics companies to adapt them against the background of the COVID-19 pandemic restrictions. The methodological background of the analysis is the analysis of financial ratios — Total Revenue Growth; Capital Expenditure Growth; Working Capital Growth; Debt/ Equity ratio; Equity/Total Assets, as well as the case method — a description of the business situation of the company in the sample of JD Logistics, which have successfully adapted to changes against the background of the COVID-19 pandemic. Analysis of the financial statements of the surveyed companies revealed several trends in their financial management during the pandemic — a decline in net income from sales after the pandemic; an increase of capital investments in 2019-2021; reduction of working capital growth rates after 2019; growth of the debt-to-equity ratio after the beginning of the pandemic; maintaining the equity to assets ratio at a stable level in 2019-2021. A set of factors influencing the exogenous and endogenous environment is identified in support of the logistics companies adaptation programme under the COVID-19 pandemic restrictions by the following blocks: “government action and regulatory policy”; “support of the company’s operation”; “company finance”; “customer relations”; “relations with suppliers”. Prospects for further research involve studying financial and market factors influencing the practice of adaptation of logistics companies in a pandemic, as well as studying the problem of adaptation of companies in the post-crisis phase after the COVID-19 pandemic.

1 Introduction

The COVID-19 pandemic broke out in late 2019 in Wuhan, China and quickly spread to more than 100 countries out of 67,500 cases by February 2020 [1]. In 2021, more than 517 million cases of infection and more than 6 million officially recorded deaths from coronavirus disease were recorded globally. The World Health Organization [1] reported the following number of cases of infection in some regions of the world for 2021: Southeast Asia — about 41 million cases, America — almost 83 million cases, Europe — more than 64 million cases.

At the same time, the largest national economies were most affected by the COVID-19 pandemic. According to the analytical platform Epidemic Stats [2] in April 2022, the TOP-5 countries (excluding China) were USA (83,567 thousand cases), India (43,102 thousand cases), Brazil (30,558 thousand cases), France (28,928 thousand cases), Germany (25,337 thousand cases). Accordingly, the largest national economies have been significantly damaged: the rate of economic activity in all sectors of the economy in general and logistics in particular is declining.

The COVID-19 pandemic has entailed a large-scale socio-economic crisis with a wide range of consequences.

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The restrictions imposed to combat the effects of the COVID-19 pandemic and to limit the spread of coronavirus disease have one of the most significant consequences. The above-mentioned restrictions affected all economic agents: households, corporations, governmental and non-governmental organizations. However, different sectors of the economy have been affected by the COVID-19 pandemic restrictions with varying degrees of severity depending on the specifics of their work and integration into the global economy. The logistics sector is one of the most severely affected by the COVID-19 pandemic restrictions. Restrictions involved complete or partial shutdowns of logistics companies, their contractors and supply chain partners, restrictions on access to transport infrastructure, strict public health and staff access regulations, increased morbidity of logistics company staff and their partners as a result of physical contacts necessitated by the specifics of work, etc.

All the foregoing affected the pace of development of logistics companies, their market and financial position, prospects for future growth and the ability to create value for stakeholders. These effects of the COVID-19 pandemic restrictions have a negative impact on the state of logistics companies, as well as encourage the development and implementation of adaptation programmes in response to constraints imposed with the aim of combating the spread of coronavirus and reducing the socio-economic burden of combating COVID-19. Current changes occurring in the exogenous and endogenous environment encourage companies and governments to implement short- and long-term adaptation plans. In the short term, such changes involve restrictions imposed with the purpose of reducing the spread of the virus, optimizing staff, attracting support through government programmes, adapting to changes in human behaviour in a pandemic, ensuring the company's financial stability, establishing relationships between counterparties and customers which have been disrupted by the pandemic. In the long run, the adaptation plans provide measures for digitalization, robotization, ensuring the stability of the company's business model.

In the context of the COVID-19 pandemic, the management of logistics companies faces the difficult task of developing and implementing an adaptation programme in order to provide a comprehensive response to socio-economic challenges at both micro and macro levels. The key steps involve adequate determination of the company's current market and financial position, understanding of exogenous and endogenous drivers that affect the company during the COVID-19 pandemic, planning of short- and long-term measures in response to the challenges underlying the decision on ensuring the company's long-term growth and enabling value creation for stakeholders. The need to take into account the trends of the modern economy creates an additional complication, which have had and will have an impact on the development of companies in the future regardless of the epidemiological situation, in particular, the digitalization trend. This

context necessitates a detailed study of the specifics of the adaptation of logistics companies to the COVID-19 pandemic restrictions. Much attention is paid to the main aspect of business process optimization based on logistics concepts and technologies [3] and the development of process optimization based on integrated pulling logistics technology [4].

Despite considerable attention to the problem of operation and adaptation of logistics companies under the pandemic restrictions, researchers do not cover the issue of adaptation of logistics companies in the long run, in particular in the context of digitalization. There is also a significant lack of practical guidance on comprehensive adaptation measures for logistics companies, especially with regard to the impact of the COVID-19 pandemic restrictions and their effects in both the short and long run.

Aim

The aim of the article is to determine the peculiarities of the adaptation of the operation of logistics companies under the COVID-19 pandemic restrictions. The aim involved the fulfilment of the following **research objectives**:

- analyse the market and financial condition of the selected logistics companies during the COVID-19 pandemic;
- analyse the factors of exogenous and endogenous environment that affect the adaptation of logistics companies during the COVID-19 pandemic;
- provide propositions for improving the practice of adaptation of logistics companies under the COVID-19 pandemic restrictions.

2 Literature review

There is a significant number of studies on the economic essence of the COVID-19 pandemic and its impact on business, in particular, logistics companies. Authors [5] study the impact of the COVID-19 pandemic on investment flows. A number of researchers study the economic essence of the logistics system and the impact of the pandemic on supply chains, in particular, the problem of pandemic restrictions for logistics systems. Researchers [6] note that the pandemic has caused significant restrictions imposed by the governments in terms of economic activity, particularly in companies' operations and logistics. This puts more strain on the infrastructure and logistics system. Authors [7] emphasize that the pandemic has placed a significant punch to the global production network and caused disruptions in the global logistics system.

Some authors [8] note that supply chains are a system of vessels of economic activity in the global economy. In [9], it is also stated that the restriction on freedom of movement, which directly affects the logistics system, is a major factor in the pandemic's impact on the logistics system. Researchers [10] emphasize that supply chain management is critical for companies, especially those

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operating regionally or globally. A wide range of exogenous and endogenous factors influence supply chains. The pandemic has significantly affected supply chain flexibility.

There is a number of studies that cover the problem of socio-economic effects of the pandemic for different sectors of the economy, industries, markets. Author [11] notes that companies have to deal both directly with the effects of the pandemic and the socio-economic effects of the crisis. Some researchers [10] distinguish closed borders between countries as the key negative effects of the pandemic restrictions. Authors [12] note that disruptions in transport and logistics have entailed significant disruptions in the proper operation of supply chains.

In [13], De Vos points out that the restrictions imposed by governments in response to the pandemic have disrupted stable economic ties and affected transport networks in the sea, rail, air and road transport. Prokopenko and Miśkiewicz [14] pay special attention to the study of the adaptation of shipping in the context of the COVID-19 pandemic. It was indicated that the COVID-19 pandemic has caused a number of serious disruptions in the transport and logistics sectors, including the cancellation of flights, which in turn has limited air freight transportation, disrupted global trade, caused labour shortages, and slowed down customs clearance [15]. Some authors [16] explore options for solutions in the transport sector.

A number of works focus on the peculiarities of the restrictions and socio-economic effects of the pandemic. In work [17] authors emphasize that the pandemic has had a number of socio-economic effects: the shutdown of production sites, the suspension and closure of businesses. According to [17], China was the first to experience supply chain failures, which subsequently affected global supply chains in different regions of the world and individual countries in the early 2020. In [18], it was noted that the COVID-19 pandemic waves resulted in numerous cases of suspension in various industries and chronic unforeseen disruptions in supply chains. In [19], authors state that disruptions in logistics systems caused by the pandemic are significantly different from the usual disruptions at the global and cross-sectoral levels, as well as the company level. In [20], Tucker, notes that lockdowns and business restrictions have resulted in numerous bankruptcies. According to [21], the pandemic has imposed restrictions on passenger traffic, has caused an economic downturn in the tourism sector.

A set of studies deal with the problem of limited supply chains, which is particularly pronounced during global crises such as pandemic, and their subsequent transformation. In [10], researchers emphasize that the sudden nature of significant negative factors of the exogenous environment pose additional difficulties in the context of a pandemic. As a result, the pandemic has revealed significant limitations in global supply chains. In turn, this requires companies to provide the effective management of supply chains. In [19], Craighead et al.

substantiate that although supply chains may have sufficient margin of safety to operate fully in cases of emergency, the ability of supply chains to painlessly adjust during global and all-encompassing crises such as the COVID-19 pandemic is objectively low. In addition to the above, it was advanced the following thesis: supply chains are vulnerable to unexpected sudden and spontaneous crises [10]. This is why the pandemic has aggravated supply chain constraints and has urged the need to adapt them adequately to the challenges of the exogenous environment.

Industry analysis, in particular, the analysis of air transport, is a particular focus in terms of problems of operation and adaptation of the logistics system during a pandemic. In [22], Tay et al. points out that the COVID-19 pandemic has significantly affected the aviation industry, which is a key component of the global logistics system. This affects the entire value chain in logistics, as well as related industries. In [23], it was noted that airlines are reorienting their aircrafts from passenger traffic to freight. Hamza [24] indicates that 90% of airlines have reduced or suspended their passenger flights as a result of the pandemic. According to [24], this directly impacts the global logistics system and world trade, because 50% of all cargo transported by air is transported by passenger flights.

A number of works study the problems of adaptation of companies to the pandemic restrictions, including constraints in the logistics system. In [25], Betti and Ni emphasize that the pandemic has urged the need to make companies more efficient and sustainable. In [9], it was pointed out that the pandemic has revealed not only the weakness of global supply chains, but also the urgent need to implement operational efficiency programmes aimed at inventory optimization, the introduction of flexible production systems, providing reliable sources of raw materials. In [26], Wang notes that the implementation of innovative solutions that promote the increasing quality of logistics services becomes especially relevant, which facilitated by digitalization. In [10], authors indicate that unexpected events that negatively affect supply chains can cause serious disruptions in the operation of a manufacturing company. This encourages the company's management to take measures to maintain secure stocks and uninterrupted production, as well as to look for alternative supply chains. In [27], Hrechyn et al. offer economic and environmental valuation models to improve supply chain performance. Research is carried out on the example of specific logistics processes for the collection and processing of woody biomass. Their result allows you to identify the most vulnerable points of the logistics system, opening up great opportunities for improving other supply systems. In addition to this thesis, researchers in [19] emphasize that supply chains also have their margin of safety and a certain extent of flexibility, but they have a low ability to quickly adapt to significant negative factors of the exogenous environment.

All these considerations and strategies are subsumed in the term of Supply Chain Risk Management (SCRM) that can be understood as "a part of Supply Chain Management which contains all strategies and measures, all knowledge, all institutions, all processes, and all technologies, which can be used on the technical, personal, and organizational level to reduce supply chain risks." [28]. The main objectives of SCRM is to increase the transparency and robustness of processes to withstand any kind of supply chain disruptions [29, 30]. Researchers are developing a number of approaches to the evolution of SCRM systems for logistics that gained importance in response to pandemic-related disruptions. In [31], Dolgui et al. propose the concept of supply chains that are open to reconfiguration because they are flexible, digitalized and efficient. In [29], was pointed out the potential of blockchain technology together with the use of smart contracts to face supply chain risks and to improve the transparency. In [32], Philipp et al. showcased how smart contracts can substitute intermediaries in the supply chain making the logistics system less vulnerable in time of pandemic. In [33], authors propose an approach to the adaptation of logistics companies during a pandemic based on effective risk management, in particular in inventory management, management of subcontractors, backup transportation route management.

The problem of complexity of programmes of the companies' adaptation in times of crisis is separately emphasized. In [34], Margherita et al. point out that having an effective adaptation plan is a critical success factor for a company in a turbulent environment, such as a pandemic. In [35], was emphasized the importance of the resistance of economic agents in the context of crisis adaptation and examines the external — social and commercial — factors of resistance. In [36], Shin and Park studied the role of top managers in successful adaptation of their companies to pandemic restrictions. In [37], authors deal with the drivers of companies' flexibility and efficiency in terms of their adaptation during the pandemic. In [38], Ketudat and Jeenanunta explore different cases of adaptation of logistics companies in a pandemic, focusing on the competitive advantages and features of the business model. Okamoto [39] states a complexity of managing both at micro and macro levels in the light of COVID-19. In [14], authors discuss the main aspects of business process optimization based on logistics concepts and technologies.

The issue of uncertainty and risk for logistics companies in the light of COVID-19 pandemics is developed in several research papers. In [40], authors consider peculiarities of managing business under uncertainty caused by COVID-19 pandemics. Shahbaz et al. [41] analyse an issue of managing supply chain under novel risks in the light of COVID-19 pandemics. In [42], authors further consider transformative response of logistics companies in the context of COVID-19. Wattanakul et al. [43] study uncertainty aspect in managing containerized logistics under COVID-19 pandemics. Was

analyzed innovative capabilities in managing logistics companies in the context of Industry 4.0 paradigm [44]. Liu et al. [45] study uncertainty of post-COVID-19 era in managing logistics companies. In [46], authors develop operational risk management tool for logistics companies in the light of COVID-19 pandemics. Kilpatrick et al [47] study specific tools for logistics companies in overcoming exogenous and endogenous disruptive effects of COVID-19 pandemics. Was outlines a need for multidimensional tool for managing risks in the context of COVID-19 [48].

However, previous studies lack research on the adaptation practices of logistics companies during the COVID-19 pandemic based on an analysis of their financial standing combined with the implementation of their short- and long-term market strategy. It makes this study topical.

3 Methods

We describe the procedure, methodological background and information background of the analysis in accordance with the aim and objectives of the research. The study of the problem of adaptation of logistics companies to the COVID-19 pandemic restrictions involved synthesis method to identify trends in the selected companies during a pandemic, as well as economic and statistical methods to process statistical information and financial statements of selected companies.

The methodological background of the analysis is the method of analysis of financial ratios, which includes the following indicators:

- Total Revenue Growth;
- Capital Expenditure Growth;
- Working Capital Growth;
- Debt/ Equity ratio;
- Equity/Total Assets.

The sample includes the leading Chinese logistics companies (5 companies), which are open joint-stock companies, regularly publish financial statements, have high quality disclosure for external stakeholders. This sample size is sufficient for analysing the practice of adaptation of companies to changes in exogenous and endogenous environment. The sample consists of the following companies:

- Deppon Logistics Co., Ltd. (China);
- JD Logistics, Inc. (China);
- STO Express Co., Ltd. (China);
- YTO Express Group Co., Ltd. (China);
- ZTO Express (Cayman), Inc. (China).

The results of the adaptation of the selected companies were studied by analysing the official financial statements of these companies, namely by analysing the financial

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ratios for 2018-2021 and identifying trends before and after the COVID-19 pandemic.

The case method is another component of the methodological background of this study—a description of the business case of *JD Logistics* included in the sample, which has successfully adapted to changes during the COVID-19 pandemic. The main criteria for selecting this particular company from the sample were the high performance of the company compared to other selected companies which were identified by analysing the financial ratios of the sample companies for the analysed period. In particular, this is a positive dynamics of Total Revenue Growth and Capital Expenditure Growth of *JD Logistics*, as well as ensuring the development of the company through adequate financing.

The methodological background selected for the analysis of the said financial ratios is based on the OECD methodological study entitled *Guidance on the Transfer Pricing Implications of the COVID-19 Pandemic* [50], where it is recommended to use financial indicators among the key performance indicators in the study of corporate governance in a pandemic. In particular, this is Total Revenue Growth as an indicator of business success and adaptation to the pandemic.

The analysis of financial ratios of the selected companies was carried out for 2018-2021 on the basis of the financial statements. Table 1 provides an explanation of the analysed financial ratios. The *Yahoo! Finance app* and *MS Excel* software packages were used to analyse the financial statements of the selected companies.

Table 1 Financial ratios used in the economic and statistical analysis of the selected companies

<i>Financial ratio</i>	<i>Comment</i>	<i>Calculation formula</i>
<i>Total Revenue Growth, %</i>	Revenue growth rate	<i>Revenue t / Revenue t-1</i>
<i>Capital Expenditure Growth, %</i>	Capital expenditure growth rate	<i>Capital expenditure t / Capital expenditure t-1</i>
<i>Working Capital Growth, %</i>	Working capital growth rate	<i>Working capital t / Working capital t-1</i>
<i>Debt/ Equity, times</i>	Debt to equity ratio	<i>Bank loans/Equity, times</i>
<i>Equity/ Total Assets, times</i>	Equity to assets ratio	<i>Equity/Assets, times</i>

Source: prepared on the basis of author's analysis

4 Results

The results of adaptation of logistics companies during the COVID-19 pandemic based on data from selected companies are provided below. Analysis of the financial ratios of the companies included in the sample revealed the following:

Decline in the Total Revenue growth rate of the sample companies after the pandemic with the resumption of growth in 2021;

Increase in Capital Expenditures of most sample companies after the onset of the pandemic;

Reduction of Working Capital Growth of most sample companies after 2019;

Growth of the Debt-to-Equity ratio of most sample companies after the onset of the pandemic;

Maintaining a stable Equity to Assets ratio of most companies in the sample in 2019-2021.

Table 2 summarizes the results of the analysis consider in more detail.

The success of the adaptation programme is reflected primarily in the dynamics of Total Revenue (Figure 1) – with “years” for axis X and “dynamics of Total Revenue Growth of *JD Logistics*” in % for axis Y. We provide illustrative material on the example of *JD Logistics* included in the sample, which most effectively implements the adaptation programme during a pandemic, as the analysis evidences. *JD Logistics* successfully develops its business on the basis of R&D, in particular, digitalization. The Total Revenue Growth most clearly indicates the success of the companies’ adaptation to the pandemic restrictions.

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Table 2 The results of the analysis of financial statements of logistics companies in the sample, 2018-2021

Ratio	2018	2018	2020	2021
<i>Deppon Logistics Co., Ltd.</i>				
<i>Total Revenue Growth, %</i>	9.7%	12.6%	6.1%	14.0%
<i>Capital Expenditure Growth</i>	57.1%	81.0%	36.7%	54.3%
<i>Working Capital Growth</i>	-47.3%	-69.2%	-56.6%	-100.0%
<i>Debt/ Equity, times</i>	0.2	0.3	0.3	0.7
<i>Equity/ Total Assets, times</i>	0.5	0.4	0.5	0.4
<i>JD Logistics, Inc.</i>				
<i>Total Revenue Growth, %</i>	27.1%	31.4%	47.7%	42.6%
<i>Capital Expenditure Growth</i>	-10.3%	-26.2%	80.0%	31.6%
<i>Working Capital Growth</i>	-31.3%	-42.9%	-51.9%	100.0%
<i>Debt/ Equity, times</i>	0.0	4.2	4.4	0.4
<i>Equity/ Total Assets, times</i>	0.0	0.1	0.1	0.5
<i>STO Express Co., Ltd.</i>				
<i>Total Revenue Growth, %</i>	21.4%	35.7%	-6.6%	17.1%
<i>Capital Expenditure Growth</i>	-15.4%	-29.6%	20.7%	19.8%
<i>Working Capital Growth</i>	-81.3%	-164.1%	136.4%	58.0%
<i>Debt/ Equity, times</i>	0.0	0.1	0.4	0.8
<i>Equity/ Total Assets, times</i>	0.7	0.7	0.6	0.4
<i>YTO Express Group Co., Ltd.</i>				
<i>Total Revenue Growth, %</i>	8.7%	13.4%	12.1%	29.4%
<i>Capital Expenditure Growth</i>	9.8%	-3.6%	55.2%	6.6%
<i>Working Capital Growth</i>	-17.1%	-25.2%	-12.5%	-4.4%
<i>Debt/ Equity, times</i>	0.3	0.2	0.1	0.2
<i>Equity/ Total Assets, times</i>	0.6	0.6	0.7	0.7
<i>ZTO Express (Cayman), Inc.</i>				
<i>Total Revenue Growth, %</i>	11.2%	25.6%	14.0%	20.6%
<i>Capital Expenditure Growth</i>	52.8%	31.3%	76.2%	1.3%
<i>Working Capital Growth</i>	-4.7%	-16.6%	-3.3%	-56.3%
<i>Debt/ Equity, times</i>	0.0	0.0	0.1	0.1
<i>Equity/ Total Assets, times</i>	0.9	0.8	0.8	0.8

Source: calculated on the basis of official financial statements of the sampled companies

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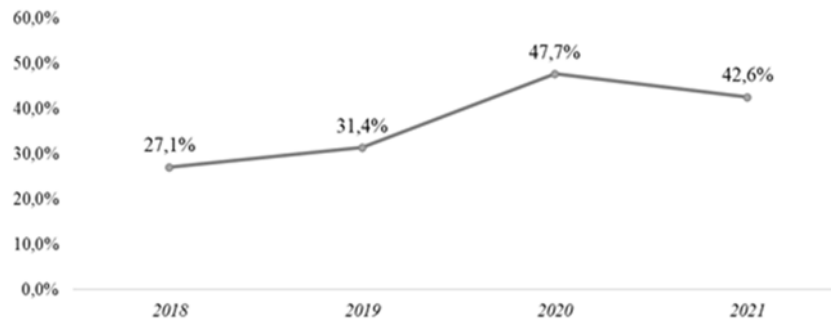


Figure 1 The dynamics of Total Revenue Growth of JD Logistics, %, 2018-2021
 Source: calculated on the basis of official financial statements of JD Logistics

Another important criterion for success of the logistics company’s adaptation programme is the dynamics of Capital Expenditure. JD Logistics increased its capital expenditures in 2020-2021 during the pandemic in response to the challenges of the socio-economic crisis (Figure 2) – with “years” for axis X and “dynamics of

Capital Expenditure Growth of JD Logistics” in % for axis Y. Increasing capital expenditures allows for the effective implementation of an adaptation programme based on the creation of competitive advantages. The company is unable to maintain market leadership in the long run without capital expenditures.

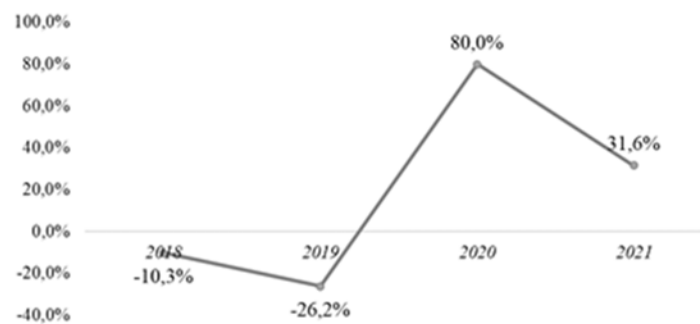


Figure 2 The dynamics of Capital Expenditure Growth of JD Logistics, %, 2018-2021
 Source: calculated on the basis of official financial statements of JD Logistics

The dynamics of Working Capital is another criterion for the implementation of the adaptation programme of the logistics company. The common practice of crisis management indicates the urgent need to increase the company performance, which is primarily implemented through the optimization of working capital in order to avoid the immobilization of funds in excess stocks. It should be noted that JD Logistics reduced the amount of working capital throughout the analysed period, except for

2021 (Figure 3) – with “years” for axis X and “dynamics of Working Capital Growth of JD Logistics” in % for axis Y. The reason is the company’s ambitious development goals in the market and high development rates, which results in the growth in inventories and accounts receivable. This thesis is confirmed by the dynamics of Total Revenue Growth, which was significantly higher than in other companies in 2021.

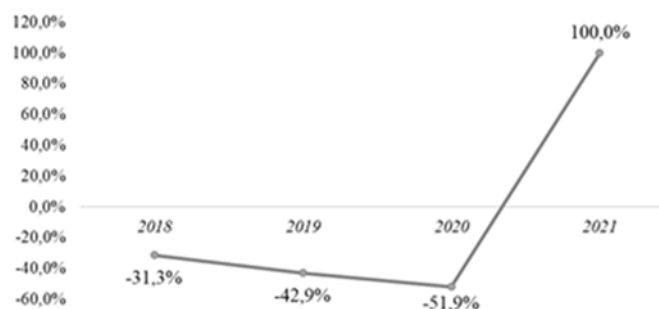


Figure 3 The dynamics of Working Capital Growth of JD Logistics, %, 2018-2021
 Source: calculated on the basis of official financial statements of JD Logistics

The company’s anti-crisis management activities entail the growth of the Debt-to-Equity ratio, especially in the context of the implementation of its adaptation programme. There are two underlying reasons for that. First, companies tend to attract additional funding to overcome the negative consequences in their exogenous and endogenous environment during a socio-economic crisis. Second, additional debt financing is attracted to

expand the company’s adaptation programme in a rapidly changing environment. JD Logistics actively attracted debt financing as part of the adaptation plan during the COVID-19 pandemic (Figure 4) – with “years” for axis X and “dynamics of Debt/Equity ratio of JD Logistics” in times for axis Y. The reason for the decline in the Debt-to-Equity ratio in 2021 is a significant increase in equity.

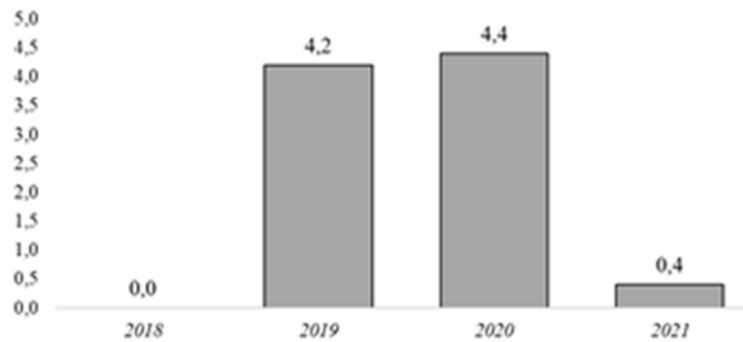


Figure 4 The dynamics of Debt/Equity ratio of JD Logistics, times, 2018-2021
 Source: calculated on the basis of official financial statements of JD Logistics

Adaptation to the pandemic restrictions requires maintaining the equity to assets ratio at a stable level, which is due to the urgent need to ensure the financial stability of the business. This is characteristic of most companies in the sample in 2019-2021. The equity to assets

ratio of JD Logistics increased after the onset of the pandemic (Figure 5) – with “years” for axis X and “dynamics of Equity/Total Assets ratio of JD Logistics” in times for axis Y. This indicates support for the company’s adaptation programme in terms of financial stability.

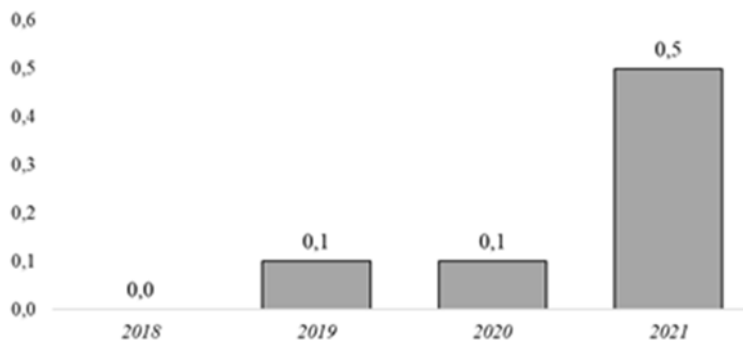


Figure 5 Dynamics of Equity/Total Assets ratio of JD Logistics, times, 2018-2021
 Source: calculated on the basis of official financial statements of JD Logistics

We will describe in more detail the adaptation programme of JD Logistics under the pandemic restrictions in the case format. JD Logistics focuses on the creation and application of innovative logistics systems. The company was the first in the world to open a fully automated warehouse in Shanghai, China, and to launch autonomous delivery vehicles. Other promising technologies such as electronic logistics, artificial intelligence and virtual reality in logistics systems are areas of interest of JD Logistics.

In 2021, JD Logistics presented a new mission: “Applying technology for a more productive and sustainable world.” JD Logistics has invested about \$12 billion in R&D since 2017, being one of the highest

indicators of investment in the development of new technologies among Chinese companies. JD Logistics aims to spread its technology in logistics, supply chains outside of China. Another goal of the company is to give its partners access to a retail platform ecosystem that includes building distribution channels and an international trade platforms [49].

JD Logistics has one of the largest service fulfilment infrastructures. The company uses a network of more than 900 warehouses covered by its open warehouse platform, which enables delivery of 90% of items the very next day after forwarding. An important component of the company’s strategy is the standardized management of the

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entire set of 10,000 delivery points [49]. Delivery points remained a weak spot for the company, especially under the COVID-19 pandemic restrictions.

JD Logistics implemented the following technological complex solution, which is designed to increase the efficiency of management and operation of delivery points: All-in-one solution reduces equipment costs at delivery points (router, WIFI, VPN, firewall).

Accessibility for businesses is enabled by backup to multiple WANs.

Security of data transfer and user access to the Internet.

No need for on-site IT staff to support the system.

Reduced system deployment costs.

Ability to open 1,000 delivery points per month [49].

JD Logistics considers itself as an e-commerce technology company and a leading provider of supply chain technology and services. Some of these technology solutions include warehouse management, transportation, shipping, after-sales service, as well as cloud services and data analytics. JD Logistics believes that the company's competitive advantage is provided by two main factors: quality customer experience and operational efficiency. The core of the company's strategy is aspiration to provide consumers with a wide selection of quality products of authentic origin at adequate prices, which is supported by investment in technology and logistics infrastructure. This is necessary to provide efficient and reliable logistics service fulfilment, which contributes to greater customer loyalty. The key of JD Logistics' value proposition is high-quality, reliable service based on the quality and speed of the delivery network and the work of the company's staff. This is enabled by the company's focus on innovation. JD Logistics has a team of more than 3.5 thousand R&D specialists. The company also has more than 4,000 patents and copyrights for computer software with more than 2,500 patents in the field of automation, robotics and unmanned vehicle control technologies [49].

JD Logistics' strategy focuses on efficient logistics and provides that the company completely covers the entire supply chain process from the purchase of goods to their transportation and their distribution to end customers. JD Logistics' warehouse network covers almost all counties and districts in China. The company's infrastructure consists of:

- More than 900 warehouses managed by JD Logistics;
- More than 1,400 "cloud warehouses" managed by third-party warehouse owners operators as part of the JD Logistics' open warehouse platform;
- The total area of warehouses is 21 million square metres (including the total area of cloud warehouses);
- More than 240,000 warehouse and delivery employees;
- 190 thousand corporate clients in 2020 [49].

It should be noted that the company did not terminate implementing its strategy after the onset of the pandemic, but rather took measures to adapt to the new conditions of the endogenous and exogenous environment. The JD Logistics continued its market growth even after 2019, as evidenced by the positive dynamics of net income from product sales. The company has decided not to reduce capital expenditures in light of the socio-economic crisis caused by the COVID-19 pandemic as its market leadership is based on technology and powerful infrastructure. The company also needed to develop its fleet of autonomous robotic delivery vehicles in Chinese cities, which is especially relevant under the pandemic restrictions. JD Logistics attracted debt financing in order to solve the problem of limited access to financing, while increasing the level of financial stability, namely the weight of equity capital in the financing structure. The comprehensive adaptation programme allows JD Logistics to maintain leadership in the market and have significant development prospects both in China and in other countries and regions of the world.

It is important to emphasise that the company takes into account various challenges of the exogenous and endogenous environment which helped it to prepare for the socio-economic crisis in general and the COVID-19 pandemic restrictions in particular. JD Logistics ensures its long-term stability, ability to adapt to the challenges of the exogenous and endogenous environment, creates value for stakeholders based on global development trends, in particular, the digitalization trend.

Table 3 presents the factors influencing the adaptation of logistics companies to the pandemic restrictions based on the results of the analysis. The impact factors are divided into the following blocks: actions of governments and regulatory policies, maintaining company's activities, company finances, customer relations, relations with suppliers.

Table 3 Factors influencing the adaptation of logistics companies to the COVID-19 pandemic restrictions

<i>Impact factor</i>	<i>Explanation</i>
<i>Government actions and regulatory policy</i>	Quarantine restrictions
	Export control
	Restrictions on the operation of the infrastructure
	Support of citizens and businesses
<i>Maintaining company's activities</i>	Availability of key personnel
	Maintaining the operation of critical infrastructure
	Ensuring the normal functioning of the production site under quarantine restrictions
	Legal support
	Adequate risk management
<i>Company finances</i>	Ensuring adequate liquidity
	Optimizing and increasing operational efficiency
	Attracting shareholders' support
	Settlements creditor banks
<i>Customer relations</i>	Checking the status of the counterparty
	Changing the value proposition to meet the new customer needs
	Industry analysis of the customer portfolio with a focus on the openness of the industry to pandemic risks
	Flexibility in working with customers
	Changes to the terms of service and cooperation with customers
<i>Relations suppliers with</i>	Status of air carriers (available capacity, financial status of the carrier)
	Status of railway carriers (restrictions on crossing the border, financial status of the carrier)
	State of marine carriers (availability of containers, financial state of the carrier)
	The condition of motor carriers (complicated customs control procedures, health condition of drivers, financial condition of the carrier)
	Continuity of warehouse facilities operation
	Health condition of employees

Source: developed on the basis of the author's analysis

The selected factors focus on both the exogenous and endogenous environment. Another advantage of the outlined set of factors is its ability to support the planning and implementation of an adequate adaptation programme by the logistics company in response to macro- and micro-level challenges. Another important aspect that distinguishes the set of factors proposed above is the focus on the short- and long run, which contributes to a more

effective adaptation of the logistics company to changes under the pandemic restrictions. The above-mentioned factors can be evaluated both in quantitative and qualitative terms and applied as part of various analytical tools of strategic and operational management of a logistics company, for example, the Balanced Scorecard.

5 Discussion

So, the importance of the drivers of adaptation of logistics companies to the pandemic restrictions was established, in particular, in terms of the dynamics of capital investments, operational efficiency, financial stability. The results of the study of a sample of logistics companies are confirmed by the previously obtained results, in particular, in terms of the importance of adequate planning of the adaptation programme, organizational flexibility, business efficiency in times of a crisis. According to [34], adequate planning of a comprehensive plan for the adaptation of companies to crisis conditions is of great importance in the pandemic context. In turn, researchers outline the drivers of flexibility and efficiency of companies in terms of their adaptation under the pandemic restrictions [37]. In [38], authors have a close position, who focus on the competitive advantages and peculiarities of the business model of small, medium-sized and large logistics companies, which necessitates individual planning of adaptation to the pandemic restrictions.

A set of factors of exogenous and endogenous environment influencing the adaptation of logistics companies to the pandemic restrictions was also identified. They involve the following blocks: government actions and regulatory policy; maintaining company's activities; company finances; customer relations; relations with suppliers. This thesis is supported by Majid [11], who emphasizes that there is a complex list of factors to be taken into account when the company makes decisions on adaptation provoked both by the pandemic directly and the socio-economic crisis. In turn Choi [17] distinguishes the factor of a significant reduction in economic activity because of the suspension or closure of production sites. In [13], De Vos develops the thesis and emphasizes the comprehensive limitation of the operation of the logistics infrastructure in terms of transportation by air, road, rail, and marine transport. In [15], Gössling et al. agrees with this and separately emphasizes the impact of the reduction in air transportation on the functioning of the logistics system as a whole and the logistics company in particular.

The importance of adequate market and financial planning of the operational work of the sample logistics companies, in particular, maintaining the dynamics of Total Revenue Growth and an adequate amount of Working Capital, was emphasized. In turn, was in [6] emphasized the importance of maintaining the operation of a logistics company during a pandemic. According to [19], it is necessary to pay significant attention to the problem of inadequate strength of supply chains caused by a large-scale unexpected crisis. Similarly, in [10], researchers emphasized the importance of adequate planning and implementation of supply chain adaptation programmes in the context of COVID-19.

Uncertainty and risk drivers in managing logistics companies under crisis situations, incl. COVID-19 pandemics is also another major area covered in this

research and supported by findings in the papers. This proposal is supported in [43] where was put forward an idea on digitalized ways of handling uncertainty for logistics companies under COVID-19. Authors in [44] further develop issue of uncertainty in managing logistics companies in terms of its innovation capabilities and risks of Industry 4.0 transition. Stewart [48] further emphasizes the need of a multidimensional approach of managing uncertainty in crisis environment for logistics companies. Shahbaz et al. [41] in turn proposes to employ a risk classification tool in terms of managing supply chain under COVID-19 crisis situations. Sharma et al. [40] elaborates on a need for a complex approach towards uncertainty and risk management for logistics companies under COVID-19 pandemics both in its exogenous and endogenous environment. This context is further developed in [42], where is proposed a transformative response for supply chain challenges under COVID-19 business environment.

Need for specific management tools dealing with uncertainty and risks is also emphasized in this paper supported by a body of other research papers. In this context authors in [45] outline a need for an integrated tool in the light of post-pandemic challenges concerning uncertainty for logistics companies. Kilpatrick et al. [47] emphasise need for smart management tools for supply chain risks under high uncertainty caused by COVID-19 pandemics. Nguyen et al. [46] put forward a proposal for usage of an operational risk analysis model in terms of COVID-19 pandemic crisis environment of logistics companies.

The great role of digitalization in the adaptation of a logistics company is also confirmed on the example of JD Logistics included in the sample. In turn, Wang et al. [26] notes the urgency of the implementation of innovative solutions that promote the growth of the quality of logistics services through digitalization. Similarly, in [31], authors justified the concept of supply chains open to reconfiguration due to their flexibility, digitalization and efficiency.

However, unlike previous studies, the results of this study indicate the importance of maintaining a balance between short-term and long-term measures in the adaptation of logistics companies to the pandemic restrictions. The results of the analysis of the dynamics of capital expenditures and the financial stability of the companies selected for this study showed the importance of long-term factors influencing the programme of adaptation to the pandemic restrictions.

6 Conclusions

The problem of adapting the operation of logistics companies to the new conditions of the exogenous and endogenous environment has become especially urgent in the context of the COVID-19 pandemic and the socio-economic crisis, which was caused both by the spread of the pandemic and restrictions imposed by the governments. The results of this study evidenced the high importance of

an adequate adaptation programme of logistics companies in the face of the challenges of both the COVID-19 pandemic and global development trends, in particular the digitalization trend. Successful planning and implementation of the adaptation programme of logistics companies under the pandemic restrictions will allow them to ensure the successful survival of the socio-economic crisis in the short run, and the creation of value for a wide range of stakeholders during the COVID-19 pandemic and in the post-pandemic period in the long run.

Analysis of the financial statements of the logistics companies of the sample revealed changes in their market and financial management in order to adapt to the COVID-19 pandemic restrictions. In particular, the analysis of the selected companies revealed:

a drop in the Total Revenue growth rate after the onset of the COVID-19 pandemic, with the recovery of growth rates in 2021;

increasing Capital Expenditures after the onset of the COVID-19 pandemic;

a reduction in the Working Capital growth rate after 2019; the growth of the Debt-to-Equity ratio after the onset of the COVID-19 pandemic;

maintaining the Equity-to-Assets ratio at a stable level in 2019-2021.

The practical value of the results obtained involve the proposed set of factors influencing the exogenous and endogenous environment in terms of adaptation of logistics companies to the COVID-19 pandemic restrictions. The following blocks of impact factors were distinguished: government actions and regulatory policy, maintaining company's activities, company finances, customer relations, relations with suppliers. The importance of planning and implementation of the logistics company's adaptation programme is emphasized both in the short- and long run, which implies different effects of the above-mentioned factors for different time horizons. The described case of JD Logistics included in the sample is also of practical interest, which successfully implemented a programme of adaptation to the COVID-19 pandemic restrictions based on digitalization and the reasonable use of market and financial drivers.

Prospects for further research involve an extended study of the factors influencing the logistics companies' programme of adaptation to the COVID-19 pandemic restrictions. The study of both financial and market factors influencing the practice of adaptation of logistics companies in the context of the COVID-19 pandemic also evoke scientific interest and is a promising research area. Further research should also examine the challenges of post-crisis adaptation of companies after the end of the COVID-19 pandemic.

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The management of construction projects in Iraq and the most important reasons for the delay

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Abstract: In Iraq, there is a vast construction movement. Still, it is accompanied by many problems, the most important of which is the delay in completing projects during the specified time. The time must be optimized by adopting the leadership practice and dedicating it to the benefit of performing the process and functions of the project. The research aims to identify the most important reasons and factors that affect the project delivery process within the specified period. The investigation initially dealt with the most important previous studies, on this subject, by researchers, then touched on the concept of construction projects, their types and details. A questionnaire containing reasons for the delay was identified and divided into several items. It concluded that the most common reasons for delays are delays in laboratory testing of materials, assignment of works to the lowest bidder, contractors' financial incompetence, and high building materials prices. The most crucial factor is to streamline building material inspection procedures, set up inspection laboratories on several occasions and assess the contractor's effectiveness and ability to implement before the project is referred financially. Organizations and individuals should coordinate their work between the construction departments to prevent any issues that may arise during completing tasks.

1 Introduction

The main objectives of this study are to identify the root causes behind time overruns on construction projects in Iraq. The building industry is one of the essential areas for a country's economic development [1]. Construction projects in Iraq, like those in other countries, necessitate a wide range of resources, including labour, funds, equipment, machinery, materials, and technical expertise. This puts building projects at risk of delays and cost overruns [2]. Whether it's simple home construction, multistory flat residences, or civil engineering projects, all projects have completion deadlines [3]. However, the primary purpose of this research is to identify the variables that contributed to delay from the employers' perspective to assist them in setting proper evaluations in future contracts via the use of quantitative data gathered in this article. Delays are rather usual. It is critical to ensure that the project is completed on schedule. It is one of the most important requirements of clients in the building industry [4]. The amount of time allotted for a construction project's completion is essential for both the project owner and the project contractor. Delays and the inability to complete work on schedule are the prime sources of construction conflicts. Time delays are common and are virtually always related to construction projects [5]. Economic crisis, poor management, ineffective design, financial corruption, lack of contractor experience, inefficient scheduling, changes in legislation and government Regulations, a lack of application of

modern technologies, poor working conditions, delays, a lack of planning, and poor project safety planning are some factors contributing to unfinished projects in the Iraqi construction industry [6]. After the invasion of Iraq in 2003, the Iraqi economy experienced several crises. Destructive policies were implemented, which worsened the situation after the civil war in 2006 and the financial crisis in 2008, which led to fluctuating oil prices that hurt the environment for construction projects [7]. The most critical factors affecting construction projects in Iraq are terrorism and its impact on worker and equipment safety. Terrorism has become a significant issue in world politics and threatens construction, particularly in countries like Iraq, where fighting and wars are common. These issues will have a substantial impact on the performance of construction projects.

2 Literature review

There are several construction project delays based on who is responsible for them. Compensation for a short delay, customers' actions or inactions may be to blame for this form of hold-up. Contractors are entitled to additional time and reimbursement for delays if they face this issue. In the case of the client's architect, the late release of drawings is an example [8]. Excusable lateness without remuneration is also responsible for the delay in the project. This type is brought on by third parties or events outside the client's and contractor's control. Unexpected weather, strikes, fires, and government acts in their

sovereign role are common examples [9]. A thorough literature analysis and survey of Iraqi project participants was conducted to learn more about the most common reasons for delays in public works projects. According to the literature research and pilot study, 65 reasons were divided into four categories: client-related, contractor-related, consultant-related, and external variables [10]. They concluded that the most significant causes of delays in Iraqi public projects were the security measures, government changes to rules and bureaucracy, official and unofficial holidays, the poor performance of lowest bidder contractors in the government tendering system, design changes made by the owner and consultants, delays in the owner making progress payments, issues with the local community, and the owner's lack of construction experience. Kazaz et al. [11] used a questionnaire to survey 71 enterprises operating in Turkey. The analysis concluded that out of 34 factors impacting project time, design and material changes were the most important, followed by payment delays and cash flow issues [11]. Abd El-Razek et al. [12] investigated the reasons for construction project delays in Egypt. The most common causes, according to the research, include contractor financing during construction, delays in owner payment to contractors, design modifications by the owner or his agent during construction, partial payments during construction, and non-use of expert construction/contractual management. Two studies have been conducted in Jordan. Sweis et al. [13] investigated the reasons for construction delays in residential projects. They found that the contractor's financial issues and the client's many change orders are the most common causes of delays [13]. Al-Momani performed the second research, which looked at the reasons for delays in 130 public projects in Jordan, including housing, office and administration buildings, school buildings, medical centres, and communication infrastructure. According to the study, the most common delays in public buildings are connected to the designer, client changes, weather, site circumstances, late deliveries, economic situations, and increased quantity [14]. Kaming et al. investigated the elements influencing the construction of Indonesia's high-rise structures. The study discovered that design modifications, low worker productivity, poor planning, and resource limitations are the main causes of delays. Two studies, one on Saudi Arabia and the other on Libya, are used as the literature review of emerging countries [15]. Shebob et al. [16] investigated the effects of delays in Libyan building projects by identifying and evaluating the elements that cause delays. Libyan construction projects discovered low workforce skills, changes in the project scope, slowness in issuing instructions, and other crucial variables. The significance of the data was tested using statistical methods, and the findings were confirmed to be significant [16]. Assaf et al. [17] obtained the reasons for delays in Saudi Arabian construction projects. Across nine primary categories, the researchers collected data on 56 different reasons.

Customers, consultants, and contractors were all included in the poll. Assaf et al. [17] also did a time performance assessment in Saudi Arabia to identify the importance of each project participant (client, consultant, and contractor). During the investigation, they discovered 73 reasons for delays [17]. Zack defined delay as an act or event which extends the required time to perform or complete work of the contract and manifests itself as additional days of work. The main causes of delay were identified as a designer, user changes, weather, site conditions, late deliveries, economic conditions, and an increase in quantity (i.e., poor design and negligence on the part of the owner, change orders, weather, site conditions, late deliveries, economic conditions, and an increase in quantity). According to the report, paying close attention to these delay causes will aid industry practitioners in reducing contract conflicts. Delays are also significantly linked to contractor failure and inefficient performance [18]. Momani [19] offered a detailed evaluation of 130 public projects, including residential, office, hospital, school, and communication facilities. Poor design, change orders, weather circumstances, site conditions, late delivery, economic conditions, and an increase in quantities were all major causes of delays in the research. The Pourroostam et al. [20] research was conducted used an essential index scale to investigate sixty-four reasons for delays in Lebanon's building sector. Financing and scheduling of subcontractors, poor contractual ties, and design modifications by owners were identified as the most significant delay causes. The researcher proposed value engineering and creative management strategies to improve efficiency and effectiveness [19] and identified the primary causes and repercussions of delay in Iranian building projects, identifying the (10) most important reasons for a delay from a list of (27) distinct sources of delay that contribute to (6) various delay effects [20].

3 Methodology

3.1 Description of the individual survey

This study intended to choose a research sample from surveyed individuals with experience and know-how in completing construction projects. The aim is to benefit from the accurate and helpful information provided by them and obtain ideas that enhance the importance of the research. In line with that, the authors of this study began distributing 62 forms that included engineers and workers in construction projects, and 50 valid responses were obtained for analysis, meaning that the response rate was 81%.

3.2 Analytical tools

The analysis relied on a set of statistical methods and means for data processing, tabulation, and scheduling and the responses contained in the questionnaire in proportion to the number of sample members [21]. The statistical program statistical package for the social sciences (SPSS)

was also used. It reviews the mathematical details of the tools used in the current research:

1. Repetitions: review the answers of the respondents.
2. Arithmetic mean: to display the average of the answers for a particular variable, which is a sum value for their number.
3. The standard deviation shows the degree of dispersion of the answers from their arithmetic means.
4. Percentage: A mathematical expression that shows the percentage of answers for a given variable.
5. The Kendall correlation coefficient [22] reveals the correlation between two variables for non-parametric studies. It is a preferred coefficient because it modifies and treats the abnormal values in the respondents' answers.
6. Simple Regression Coefficient: to measure the effectiveness of an independent variable on a dependent variable.

7. The f-test shows each variable's effectiveness and verifies the signature of the functional relationship between the variables.

3.3 Description of the individuals surveyed

The investigation aimed to select a research sample from individuals surveyed who have experience and knowledge of completing construction projects and their requirements. This was done to ensure that accurate and helpful information is provided and to obtain ideas and suggestions that enhance the importance of the research. In line with that, the researcher began distributing 62 forms that included engineers and workers in construction projects, and (50) valid records were obtained for analysis, meaning that the response rate is (83%), and Table 1 shows the characteristics of the individuals surveyed in the construction projects.

Table 1 Characteristics of the research sample

Distribution of the respondents according to gender													
male					female								
number		%			number		%						
44		88%			6		12%						
Distribution of the respondents according to age groups													
From 25-29		From 30-39			From 40-49		From 50-59		<60				
NO.	%	NO.	%	NO.	%	NO.	%	NO.	%				
8	16%	21	42%	15	30%	5	10%	1	2%				
Distribution of the respondents according to years of service													
1-5		6-10		11-15		16-20		21-25		26-30		>31	
NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
10	20%	10	20%	5	10%	10	20%	10	20%	4	8%	1	2%
Distribution of the respondents according to academic achievement													
Doctor				Master				Bachelors				Diploma	
NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
-	-	1	2%	2	4%	47	97%						

4 Analysis and findings

The answers to the researched variables are described and interpreted in the light of the data and information that was done either using a questionnaire to know the results or using descriptive statistical methods (means Standard deviations, weighted percentage). The statistical effort requires early detection of the strength and weakness of the answers to reach its goal. The use of a heptagonal Likert scale [23], which consists of seven fields distributed from the highest weight, which is the field which is represented

by the answer field (7), to the lowest weight, which is the first field, which is represented by the answer field (1), and between them, there are five other, weights (6,5,4,3,2). Thus, it's hypothetical mean is the value of the weighted arithmetic means equal or greater than (4), which means that the sample on the variable tends to agree on its availability. Still, if the values are less than 4, the sample answers to the variable tend to disagree. This investigation also found that there is a discrepancy in the results of the sample according to the answers of the piece researched in the projects (Table 2).

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Table 2 The level of the research variables by extracting the arithmetic averages and standard deviations

Questions Time planning	The daily work falls within a list of the tasks that I want to accomplish daily within paragraphs arranged in order of priority	The project activities shall be carried out according to an organized schedule to define and document the work	Setting the project according to a timetable	Adjust the daily project schedule as part of the control process. To be supervised by management	Scheduling daily activities often leads to the speedy completion of planned projects	TOTAL
Strongly agree	6	2	0	2	2	
Agree	19	6	8	3	7	
Somewhat agree	18	22	9	14	9	
Undecided	3	5	5	4	3	
Somewhat disagree	2	12	27	17	16	
Disagree	1	2	1	8	10	
Strongly disagree	1	1	0	2	3	
N (No. of respondents)	50	50	50	50	50	
Mean	5.3400	4.4200	3.9200	3.7400	3.6800	4.22
Standard deviation	1.22241	1.31071	1.20949	1.48200	1.64677	0.9118
Weighted percentage	76.3	63.1	56.0	53.4	52.6	60.3
Questions determine priority points	The organization sets priorities for project completion to be consistent with its strategic objectives	The organization sets a timetable for achieving the project objectives, which helps in the speed of their achievement	Delegating authority is one of the priorities of the organization's work in completing its projects	Complete projects on time, one of the priorities of the organization's work	The organization is keen to adhere to the deadlines for the completion of projects and considers them among its main priorities	TOTAL
Strongly agree	2	1	1	2	4	
Agree	3	7	6	6	6	
Somewhat agree	10	7	9	9	15	
Undecided	4	5	5	4	1	
Somewhat disagree	21	23	19	16	12	
Disagree	7	5	7	7	4	
Strongly disagree	3	2	3	6	8	
N (No. of respondents)	50	50	50	50	50	
Mean	3.5600	3.7000	3.6400	3.5800	3.8571	3.6776
Standard deviation	1.47302	1.43214	1.49503	1.69139	1.88193	1.3164
Weighted percentage	50.9	52.9	52.0	51.1	55.1	52.5
Questions about wasting time	There is clarity in the responsibilities for the work of the organization despite the overlap in the powers	The result of the organization in the spirit of one team at work	Specialized and efficient staffs work in our organization	The organization can provide financial resources promptly	There is an assortment of heads and supervisors within the same project	
Strongly agree	3	2	2	3	2	
Agree	5	7	6	3	3	
Somewhat agree	8	10	10	7	5	
Undecided	5	2	3	4	3	
Somewhat disagree	18	22	20	18	22	
Disagree	8	6	7	10	8	
Strongly disagree	3	1	2	5	7	
N (No. of respondents)	50	50	50	50	50	
Mean	3.6800	3.8600	3.7600	3.3800	3.1600	
Standard deviation	1.60916	1.49843	1.53277	1.62744	1.54339	
Weighted percentage	52.6	55.1	53.7	48.3	45.1	
Strongly agree	3	2	2	3	2	
Questions about wasting time	Individuals in the organization rely on the method of self-censorship	There is a severe interest in preparing project implementation follow-up	The organized communication system between the relevant authorities as being effective	Many of the decisions taken in the organization are well thought out	TOTAL	
Strongly agree	3	3	2	2		
Agree	6	4	5	3		
Somewhat agree	4	4	9	6		
Undecided	2	2	1	3		
Somewhat disagree	15	18	16	15		
Disagree	16	10	12	4		
Strongly disagree	4	9	5	17		
N	50	50	50	50		
Mean	3.3200	3.1200	3.4000	2.7959	3.3832	
Standard deviation	1.73134	1.73370	1.67819	1.70758	1.2231	
Weighted percentage	47.4	44.6	48.6	39.9	48.3	

The time management variable included three dimensions (time planning, setting goals and priorities, and avoiding time wasters). With a standard deviation of (0.9118), and since the hypothetical mean is (4) on the scale area, the research sample agrees about the importance of time planning. It was obtained that the highest average of 5,340; as for the lowest standard of my account, was obtained in paragraph (5) related to (scheduling daily activities plays a high role in the speed of completion of the planned projects), and their mean was 3.680.

As for the second dimension (setting goals and priorities), the weighted mean reached (3.6776) with a standard deviation of (3146.1), and since the hypothetical mean was (4) on the scale area, this indicates that the respondents' opinions were almost in agreement towards the stage of setting goals and priorities.

The relative importance of the location reached (52.5), which is an average percentage, and paragraph (5) related to (the organization's keenness to adhere to the deadlines, considering them among its main priorities) achieved the highest arithmetic mean (3.8571), while the lowest arithmetic mean was obtained by the paragraph (1). The value is related to the organization sets priorities for the completion of projects to be consistent with its strategic objectives and it's an is 3.5600.

As for the third dimension, avoiding time wasters, the weighted arithmetic means reached (3.3832) with a standard deviation of 1.22. Since the hypothetical mean was (4) on the scale area, this indicates that the average response of the respondents was almost in agreement towards avoiding time wasters. As for the relative importance of the stage, it reached (48.3), which is a semi-average percentage; paragraph (2) related to (the organization prevails in the spirit of one team at work). It achieved the highest average calculation of (3.8600), while the lowest arithmetic mean was obtained by paragraph (9) related to (many decisions taken in the organization carefully studied) whose arithmetic mean reached 2.7959.

The time management variable reached the arithmetic mean (3.7620) with a standard deviation (1.04609), and since the hypothetical mean is (4) on the scale area, this indicates good progress in a positive direction towards time management, and the relative importance of the variable. It reached (53.7), which is a good percentage, and this indicates that the respondents focus on completing their projects within the specified time and identifying the obstacles that hinder work.

The project completion stages included four dimensions: the project initiation stage, the project's planning stage, the project implementation stage, and the project's closing or termination stage.

Regarding the first dimension (stages of starting the project), the weighted arithmetic mean was 3.928, with a standard deviation of 1.3048. Since the hypothetical mean

was (4) on the scale area, this indicates the average answers of the respondents were close in terms of the agreement on this dimension. The relative importance of the stage reached 56.1, which is higher than the average. Paragraph 3 related to the project team's experience and competence, achieved the highest arithmetic mean of 4.2200, while paragraph 5 on project management's follow-up to changes and conditions had the lowest arithmetic mean of 3.7000.

About the second dimension (the project planning stage), the weighted calculation means reached 3.628 with a standard deviation of 1.3407. Paragraph 2, related to the project management determining start and end dates of activities, achieved the highest arithmetic mean of 3.8000. Paragraph 5, related to effective communication plan for risk management, contracting, and auditing, had the lowest arithmetic mean of 3.20. As for the third dimension, the project implementation stage, the weighted arithmetic mean reached 33.96 with standard deviations of 1.5458. Since the hypothetical mean was (4) on the scale area, this indicates a simple agreement for the sample of respondents about the project implementation stage. As for the relative importance of the location only, it reached 48.5, which is close to the average. Paragraph (1) related to (the project management is keen to apply international standards and use modern technology methods to improve the quality of work) achieved the highest average calculation of (3.5200), while the lowest arithmetic mean was obtained by paragraph (5) related to the project management checks and inspections. As per the fourth dimension (the stage of closing or termination of the project), the mean was 3.196, and the standard deviation was 1.5526. Since the hypothetical norm was (4) on the scale area, this indicates that the average answers of the respondents agreed to some extent about the stage of closing or ending the project. As for the importance, the relative level for the setting only reached (45.7), which is close to the average. Paragraph (2) related to (the project management possesses high confidence in the qualifications, performance and achievements of its workers) achieved the highest arithmetic mean of 3.5400, while the lowest arithmetic mean was obtained by Paragraph (5) related to (take Project management reviewing what has been achieved and research by performing better than its competitors) (Table 3). Its arithmetic mean reached 2.7600 for the variable as a whole (Management and Completion of projects went the arithmetic mean) (3.5370) and with a standard deviation of 1.2155 and since the hypothetical mean was (4) over an area. The scale indicates that the respondents were not satisfied with the processes of completing their projects within the specified time, but this did not prevent them from presenting what they could accomplish even as much as possible. The variable in question only had a relative importance of 50.5, indicating a medium level of importance.

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Table 3 The level of the study sample's answers to the paragraphs of the second phase (stages of project completion)

Questions regarding Project start	The project management obtains information from multiple parties for the feasibility study	The project management is keen on defining the activities and scheduling the material resources for the project	The project team consists of experienced and competent individuals	Establishing an office for the project to listen to the opinions of workers and beneficiaries	There is a follow-up by the project management for the change in the project's conditions	TOTAL
Strongly agree	3	2	2	1	2	
Agree	4	7	8	8	7	
Somewhat agree	15	16	16	11	9	
Undecided	5	4	4	3	4	
Somewhat disagree	12	14	15	16	17	
Disagree	7	3	3	7	6	
Strongly disagree	4	4	2	4	5	
N (No. of respondent)	50	50	50	50	50	
Arithmetic mean	3.8800	4.0800	4.2200	3.7600	3.7000	3.923
Standard deviation	1.64924	1.58874	1.48860	1.62330	1.66905	1.3048
Weighted percentage	55.4	58.3	60.3	53.7	52.9	56.1
Questions About project planning	Project management prepares project phases within a specified schedule	The project management determines the start and end date of each project activity.	Project management can provide resources at the right time and in quantity	Project management takes environmental variables into account when setting the project schedule	The project management is keen to develop an effective plan for communication between departments to ensure risk management contract and review	TOTAL
Strongly agree	2	3	2	2	1	
Agree	6	5	4	4	8	
Somewhat agree	10	11	12	10	6	
Undecided	3	3	8	4	3	
Somewhat disagree	19	18	13	20	11	
Disagree	8	8	7	9	9	
Strongly disagree	2	2	4	1	12	
N (No. of respondent)	50	50	50	50	50	
Mean	3.7400	3.8000	3.7400	3.6600	3.2000	3.628
Standard deviation	1.54933	1.59079	1.56244	1.45139	1.86263	1.3407
Weighted percentage	53.4	54.3	53.4	52.3	45.7	51.8
Questions						
Project execution	The project management is keen to apply international standards and uses modern technology methods to improve the quality of work	Project activities are carried out exactly as planned and according to the schedule	Project management can deal with unexpected crises successfully	Project management follows the method of external control in the project implementation process	The project management carries out sudden checks and inspections to verify the quality of the implementation of the project contract and review	TOTAL
Strongly agree	3	2	1	1	2	
Agree	5	6	6	7	4	
Somewhat agree	12	10	9	8	6	
Undecided	4	2	5	2	3	
Somewhat disagree	10	13	13	14	16	
Disagree	3	7	9	13	13	
Strongly disagree	13	10	7	5	6	
N (No. of respondent)	50	50	50	50	50	
Arithmetic mean	3.7400	3.4200	3.4400	3.4000	3.2000	3.396
Questions						
Close or terminate the project	The blueprint for the project is matched with what has been accomplished, and the results are recognized and matched	The project management has high confidence in the qualifications, performance, and achievements of its workers	Project management seeks to enhance trust with service beneficiaries	The project management aims to create a good reputation among its competitors through its achievement	Project management takes a review of what has been achieved and research by doing better than its competitors	TOTAL
Strongly agree	3	2	3	2	2	
Agree	5	6	4	3	5	
Somewhat agree	8	9	5	5	5	
Undecided	2	4	5	3	0	
Somewhat disagree	11	13	13	14	12	
Disagree	15	11	16	17	7	
Strongly disagree	6	5	4	6	19	
N (No. of respondent)	50	50	50	50	50	
Arithmetic mean	3.3600	3.5400	3.3000	3.0200	2.7600	3.196
Standard deviation	1.80340	1.70486	1.66905	1.58423	1.90123	1.5625

This suggests that respondents have an intermediate level of knowledge about the problem of completing construction projects due to various obstacles, such as lack of experience and efficiency, lack of resources and development, and adherence to outdated methods. A lack of a scientific research unit to keep pace with scientific development also contributes to these difficulties. The evaluation also reported that the delay of one activity makes it impossible to start the next one, which is similar to the research of [24,25].

5 Testing the correlation and effect between the research variables

5.1 The Kendall correlation coefficient was used to test the hypotheses about the correlation

5.1.1 The first sub-hypothesis test

There is a significant correlation between time planning and project completion stages (initiation, project planning, project implementation, project closing)

Table 4 Values of Kendal correlation coefficient between time planning and project completion stages (project start-up, project planning, project implementation, project closing)

	Project started	Project planning	Project execution	Close the project	Project completion stages
Time planning	0.0367	0.336*	0.457*	0.290*	0.414*
p-value	0.001	0.001	0.002	0.005	0.000
Significance level at the level of significance 0.05	moral	moral	moral	moral	moral

* It indicates a significant level of 0.01.

5.1.2 Test the second sub-hypothesis for the first central hypothesis

There is a significant correlation between setting goals, priorities, and project completion stages (Initiating the project, planning the project, implementing the project, and closing the project). The results showed a positive and good moral relationship. The correlation was recorded between setting goals, priorities, and project completion stages (project start-up, project planning, project implementation, and project closure).

And there is a correlation between setting goals and

The results indicate a positive and significant relationship, where the correlation between time planning and project completion (project start, project planning, project implementation, project closure) was recorded in the amount of (0.367, 0.336, 0.457, 0.290, 0.414), respectively. It is a significant correlation at the level of Significant 0.01. If the P-value is less than the significance level. A considerable correlation indicates that time planning has a meaningful relationship in those dimensions. As for the correlation between time planning and project completion stages, the Kendal correlation coefficient reached 0.414. It is significant, and this indicates a significant correlation between time planning and project completion stages. Table 4 shows the values of Kendall's correlation coefficient between time planning and project completion stages.

priorities and (project start-up, project planning, project implementation, and closing the project) of (0.453, 0.415, 0.496), respectively, and it is significant at the level of significance (0.01) if the P value is less than the level of morale. Thus, there is a moral correlation relationship, and this indicates that setting goals has a significant, influential relationship in those dimensions as for the correlation relationship (0.513). This shows the existence of a substantial correlation between setting goals, priorities and project completion stages. The correlation coefficient reached Kendall (0513) (Table 5).

Table 5 Shows the values of Kendall's correlation coefficient between setting goals, priorities, and project completion stages (project start-up, project planning, project implementation, project closure)

	Project started	Project planning	Project execution	Close the project	Project completion stages
Setting goals and priorities	0.453*	0.415*	0.496*	0.403*	0.513*
p value	0.002	0.000	0.001	0.000	0.000
Significance level at the level of significance 0.05	moral	moral	moral	moral	moral

* It indicates a significant level of 0.01.

5.1.3 Test the third sub-hypothesis of the first central hypothesis

There is a significant correlation between avoiding time wasters and the stages of project completion (project start,

project planning, project implementation, and project closure).

The results indicated a positive and good significant relationship, where the correlation between avoiding time

wasters and the stages of project completion (project start, project planning, project implementation, project closure) was recorded as (0.314, 0.354, 0.455, 0.442), respectively, which is a significant correlation at the level of (0.01) important. Suppose the P-value is less than the level of significance. In that case, there is a significant correlation, which indicates that avoiding wasting time has a

substantial relationship in those dimensions, as for the correlation relationship between avoiding time wasters and the stages of project completion. The Kendall correlation coefficient reached (0.442), indicating a significant correlation between avoiding time wasters and the locations of project completion (Table 6).

Table 6 Shows the values of the Kendall correlation coefficient between avoiding time wasters and the stages of project completion (project start, project planning, project implementation, project closing)

	Project started	Project planning	Project execution	Close the project	Project completion stages
Avoid wasting time	0.314*	0.354*	0.455*	0.360*	0.442*
p-value	0.004	0.001	0.000	0.001	0.000
Significance level at the level of significance 0.05	moral	moral	moral	moral	moral

* It indicates a significant level of 0.01

5.2 Test the second central hypothesis

There is a significant correlation between time management and project completion stages. The results indicate a positive and good considerable relationship. The correlation between time management and project stages was recorded, as the correlation coefficient amounted to (0.433, 0.426, 0.541, 0.380, 0.533) respectively, which is a significant correlation at the significance level (0.01).

Suppose the value of the P-value is less than the level of energy. In that case, there is a significant correlation, indicating that time management has a substantial relationship in those dimensions. As for the correlation between time management and project completion stages, the Kendall correlation coefficient was (0.533), indicating a significant correlation between time management and project completion stages (Table 7).

Table 7 Shows the values of the Kendall correlation coefficient between time management and the stages of project completion

	Project started	Project planning	Project execution	Close the project	Project completion stages
Time management	0.433*	0.426*	0.541*	0.380*	0.533*
p value	0.000	0.001	0.002	0.000	0.000
Significance level at the level of significance 0.05	moral	moral	moral	moral	moral

* It indicates a significant level of 0.01

6 Second impact tests

6.1 The first sub-hypothesis test

There is a significant effect of covering the time in the project completion stages, and β amounted to (0.880). Table 8 shows the regression analysis results of the effect

of covering time on the likely variable, the stages of project completion.

The F value is calculated (37.078), which is greater than the tabular value at the level of significance (0.01,0.05) and below the degree of freedom (48). The R^2 explained (44%) of the number of contributions made in the stages of jazz projects, and the respective value is presented in Table 8.

Table 8 Results of the impact of the time coverage phase on the project's completion phases using the ordinal logarithmic model

Independent variable	Dependent variable	Constant value	β parameter value	Coefficient value R^2	The calculated F value
Time planning	Project completion stages	-0.177	0.880	44%	37.078

Beta (β) refers to the probability of Type II error in a statistical hypothesis test. The first dimension by one unit leads to a speed in the completion of projects by (0.880). An F-value is the ratio of two variances. If the F-value was Tabluted below the significance level (0.05), then the degree of freedom (48) is 3.84. On the other hand, if the F-value is tabulated below the significance level 0.01, then

the degree of freedom (48) = 10.

6.2 The second sub-hypothesis test

There is a significant effect of setting goals and priorities in the project completion stages. Table 9 shows the regression analysis results of the effect of setting goals and priorities on the approved variable and stages of

project completion. It is noted that this dimension has a significant impact on the steps of project completion, as the calculated F value was (46.44), which is greater than the tabular value at the level of significance (0.01, 0.05). Under the degree of freedom (48), and (R²) explained (41%) of

the estimated contributions made in the stages of project completion, and the value β amounted to (0.533). It also indicates that the change that occurs in the second dimension by one unit leads to Increasing project completion stages by (0.533).

Table 9 Shows the impact of setting goals and priorities in the stages of project completion using the ordinal logarithmic model

independent variable	dependent variable	constant value	β parameter value	coefficient value R ²	The calculated F value
Setting goals and priorities	Project completion stages	0.621	0.533	41%	46.44

7 Main Hypothesis Test

There is a significant effect of time management in the stages of project completion. Table 10 shows the regression analysis results of the effect of time management on the adopted variable, stages of project

completion. 48) R² explained (39%) of the contributions made in the project completion stages. The β value amounted to (0.852) and indicates that the change that occurs in the independent variable time management by one unit leads to an increase in the project completion stages by (0.852).

Table 10 Shows the results of the impact of time management on project management and completion using the ordinal logarithmic, linear model

independent variable	dependent variable	constant value a	β parameter value	coefficient value R ²	The calculated F value	Indication level
Avoid wasting time	Project and achievement management	0.109	0.852	39%	45.33	There is an effect

8 Conclusions

The current study's has some outcomes and suggestions, which are given below:

1. Most respondents ignore the importance of time management, especially with their daily schedules. This, combined with a lack of credibility and realism in project scheduling at both lower and upper management levels, leads to projects not being completed within the planned timeframe and at the required pace.
2. The lack of seriousness of the surveyed organizations in achieving their strategic objectives leads to the lack of priorities for the implementation of projects. The main reason for not completing the strategic goal is the management and central funding of the surveyed organization's construction projects.
3. The research sample tends to be more interested in planning time than it is concerned with setting goals and priorities and avoiding waste of time due to completing business requirements.
4. The plans for the completion of projects do not agree with the strategic directions, which are considered among its main objectives due to the lack of coordination between activities.
5. The research sample lacks the fundamental mandate of its engineers, which leads to sluggishness in the performance of tasks, scheduling work and studies. It is required during the specified time and is also a routine that hinders taking urgent decisions during the completion period of the project.

6. The study is counting the balance of the research sample with the deadlines specified for project completion and measuring project implementation according to a timetable. This may be due to the nature of the unstable conditions within the sample.
7. The absence of a team-working method makes the work challenging and complicated.

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Waste analysis of tapioca unloading process with lean supply chain approach in Makassar Port

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Keywords: lean supply chain, value stream mapping, waste, fishbone diagram.

Abstract: In the process of dismantling tapioca flour, waste occurs due to activities that do not provide added value (Non-Value Added). The purpose of this study is to identify and analyze the types of waste and then propose improvements to eliminate activities that do not provide added value. By using the concept of lean supply chain and value stream mapping (VSM) it is expected to eliminate activities that do not provide added value and make the company more productive. Through the analysis of seven wastes and fishbone diagrams, it is known that the biggest causes of waste are waiting for the arrival of workers, waiting for pilot/tug boats, waiting for trucks to arrive, and working on sacks that have fallen and torn. Meanwhile, the recommendations given are to coordinate and evaluate the performance of workers, increase the number of pilot/tug boats and trucks, and supervise the unloading process to minimize mistakes made by workers. With the proposed improvement, the cycle time, which was originally 335.34 minutes decreased to 271.97 minutes, and for Process Cycle Efficiency (PCE) which was originally 68.30% increased to 84.22%.

1 Introduction

Gelora Samudera Company is engaged in loading and unloading services at Makassar Port. Makassar Port is one of the ports in Indonesia which is located in Makassar, South Sulawesi for loading and unloading activities. One of the problems that exist here is that there is waste in the process of demolition activities that are here, namely the existence of waste in the process of demolition activities that do not provide value added (Non-Value Added) and have an impact on waiting times and cause losses.

Martono [1] found that waste is an activity that does not add value to business and manufacturing processes. By using Value Stream Mapping, it can be seen what kind of waste that occurs in the process of dismantling tapioca activities. The process of dismantling activities at Gelora Samudera Company still has waste, so research is needed that can increase company productivity in terms of effectiveness and efficiency. This research applies the concept of Lean Supply Chain and Value Stream Mapping. In addition, Anne-Marie et al [2] concluded that lean supply chain is an overall supply chain strategy to increase effectiveness. Lean Supply Chain also aims to optimize all processes from all supply chains, seek simplification, reduce waste and reduce activities that do not provide added value.

Moreover, Irvansyah [3,4] recommended the value stream mapping is a tool used to describe or describe the entire system and value stream in the supply chain. Therefore, this method could be used to show the detailed

time of each activity to determine the type of waste that occurs in the unloading process at Gelora Samudera Company in Makassar Port and analyze the main problems using seven waste and fishbone diagrams.

2 Methodology

2.1 Data collection dan processing

This study was conducted in August-September 2021, this research was conducted at Gelora Samudera Company, which is located at Makassar Port, Jl. Nusantara No. 378 Makassar City, South Sulawesi. In this study, the primary data in this study were obtained directly from the research object through observation and interviews, while secondary data were sequence of unloading activity process and unloading activity process time.

Furthermore, data processing used in this study uses a Lean Supply Chain approach which consists of:

1. Current State Mapping
Process Activity Mapping or Big Picture Mapping is used as a tool to describe or describe the entire system and value flow in the supply chain [3,5,6].
2. Waste Identification
There are seven types of waste in the manufacturing process [1,7]:
 - a. Overprocessing,
 - b. Transportation,

- c. Unnecessary Motion,
- d. Defect,
- e. Waiting Time,
- f. Overproduction.

3. Inventory

Determining the Most Influential Waste After that is the processing of questionnaires that have been distributed to the Chief Officer, Chief Stevedoring, and Foreman, to find out what type of waste is the most influential and with the highest level of urgency.

4. Root Cause

Fishbone diagram is an analysis that can make it easier to find the causes of a problem that arises [3,8].

5. Proposed Improvements

Proposed improvements are given based on the most influential waste and the highest level of urgency, with the hope that the company will become smoother, more productive, effective, and efficient.

6. Future State Mapping

In the Activity Mapping Future State process, it provides a physical flow of information, the time required for each activity, the distance traveled in each stage of the process in the post-repair state.

7. Process Cycle Efficiency (PCE)

This calculation is carried out to compare the company's performance before and after the improvement by using the efficiency of the process cycle (Process Cycle Efficiency) [4,9,10], with the following formula:

$$\text{Process Cycle Efficiency} = \frac{\text{Value Added Time}}{\text{Total Lead Time}} \times 100\% \quad (1)$$

3 Result and discussion

3.1 Process activity mapping current state

Following are the results of direct observations that will be described in the table above, there are 32 activities

consisting of 21 operating activities or 50.71% with a total time of 170.04 minutes, 8 transportation activities or 34.49% with a total time of 170.04 minutes, and 3 delay activities or 14.81% with a total time 49.65 minutes.

3.2 Big picture mapping current state

The Big Picture Mapping above illustrates the flow of the tapioca unloading process at the Makassar Port which is divided into several stages, namely the preparation of the docking ship starting from the ship preparing to dock to the dock by turning on the main engine, then pulling the ship with a pilot/tug ship to the dock, after the ship is leaning then the process of anchoring and tying the rope to the pier is carried out. The next activity is the work preparation process starting with a work agreement discussion between the Chief Officer and Chief Stevedoring, after the discussion, the Chief Officer will instruct the operator to open the hatch cover/pontoon with a crane, after the hatch is open, Foreman will install protective nets on the side of the hatch. Hull. The next activity is the unloading activity. After the hatch is open and the hull nets are installed, the next activity is sea workers arranging and stacking tapioca sacks on sling ropes, after the sacks are arranged the next process is lifting the sacks using a crane, while the sacks are lifted using a crane, tallyman counts and records the number of sacks lifted, then the sacks are lowered into the back of the truck, after the sacks are unloaded in the trunk, the land workers arrange the unloading of the unloaded sacks, after the truck is fully loaded the tallyman will make a road transport bill to the driver. The next activity is the driver sending tapioca flour to the destination warehouse. From the observations made, the delivery of tapioca flour to the destination warehouse takes 45 minutes.

Figure 1 describes the process flow of tapioca unloading activities at Gelora Samudera Company at Makassar Port. So, it is known that the total value of the value-added activity is 335.34 minutes. While the unloading is 106.27 minutes. From this description, it indicates that in the process of unloading activities, there is still waste that can be reduced if possible.

Waste analysis of tapioca unloading process with lean supply chain approach in Makassar Port
 Suradi Suradi, Dirgahayu Lantara, Ahmad Padhil

Table 1 Activity data (unloading) tapioca

No	Activity	Time (Minutes)	Total	Activity Category					Activity Type	
				O	T	I	S	D		
Preparation of the Vessel										
1	Ship Preparation	30.25	153.85	O					VA	
2	Waiting for the guide/tug boat	30.71						D	NNVA	
3	Pulling Ship	61.56			T				VA	
4	Ship docks and tie ropes	31.33		O					VA	
Work preparation										
5	Work agreement talks between Chief Officer and Chief Stevedoring	3.27	73.71	O					VA	
6	Operator prepares Crane	14.36		O					NNVA	
7	Opening and folding hatch tarps	20.14		O					NNVA	
8	Open hatch/pontoon hatch	21.37		O					VA	
9	Attaching the Hook to the Crane	2.49		O					NNVA	
10	Attaching the sling to the crane	1.19		O					NNVA	
11	Installing the ship's hull nets	10.90		O					VA	
Unloading										
12	Waiting for Labor to come	8.42	62.77					D	NVA	
13	Marine Workers enter the hold	3.95			T					NNVA
14	Waiting for Trucks	10.52						D		NVA
15	Foreman steers Truck in	2.54			T					NNVA
16	Land workers get on the Truck	0.21			T					NNVA
17	Marine workers arrange tapioca sacks on rope slings	13.46		O						VA
18	Lifting tapioca sacks from ship to truck using a crane	2.38		O						VA
19	Tallyman counts and records the number of sacks lifted	2.04		O						VA
20	Removing the sling	0.25		O						NNVA
21	Dropping the sack onto the Truck	0.60		O						VA
22	Sewing the sack that was torn from the fall	2.00		O						NNVA
23	Picking up a fallen sack	2.63		O						NVA
24	Attaching the sling to the boat	0.17		O						NNVA
25	Returning the sling strap to the Ship	1.51		O						NNVA
26	Land workers arrange unloading sacks in the Truck	5.13		O						VA
27	Land workers get off the Truck	0.15			T					NNVA
28	Foreman steers Truck out	1.70			T					NNVA
29	Tallyman makes a road transport bill to the driver	1.78		O						VA
30	The driver put the rope and tarp on the truck	2.81		O						NNVA
31	The driver took the transport receipt from Tallyman	0.54			T					NVA
Flour Delivery To Storage Warehouse										
32	Transportation of Tapioca Flour to Destination Warehouse (Parangloe)	45.00		45.00		T				VA
Total				335.34	21	8	0	0	3	32

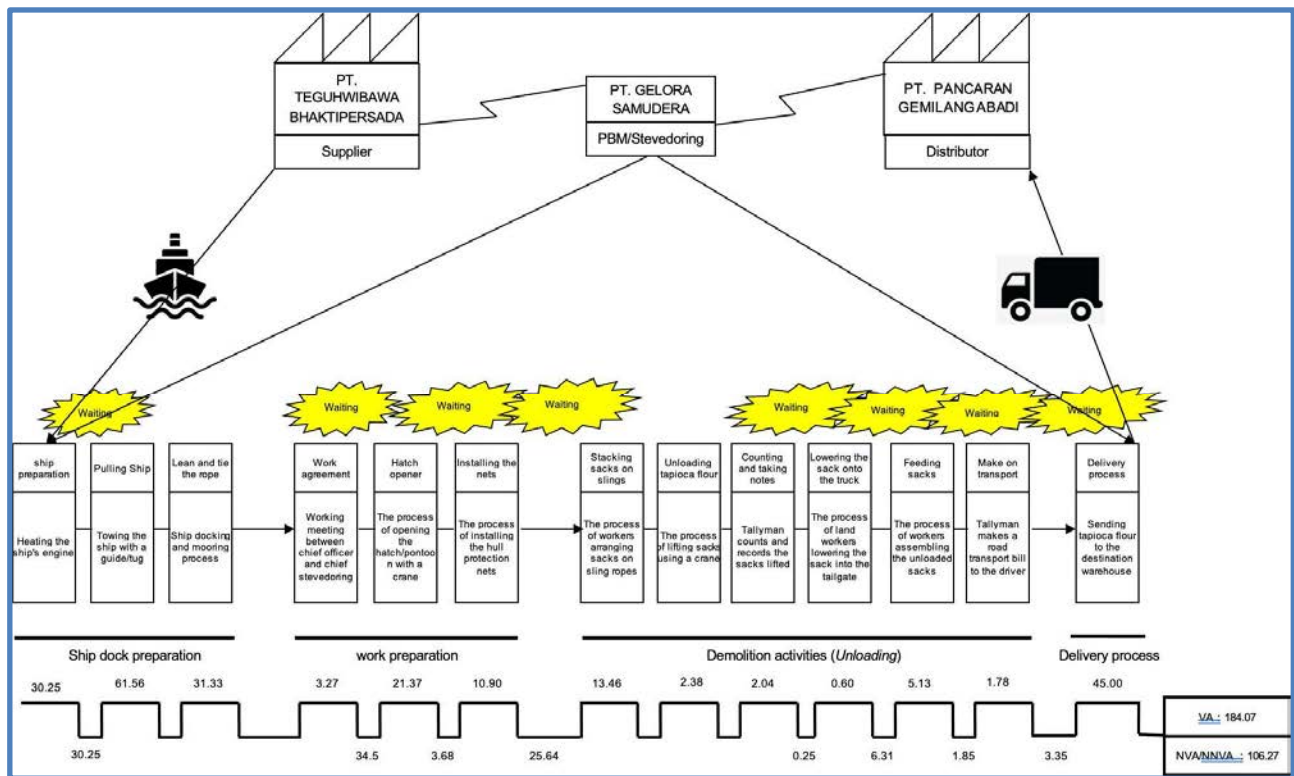


Figure 1 Big picture mapping current state

3.3 Determination of the most influential waste

The following are the results of the weighting of waste which will be presented in Figure 2.

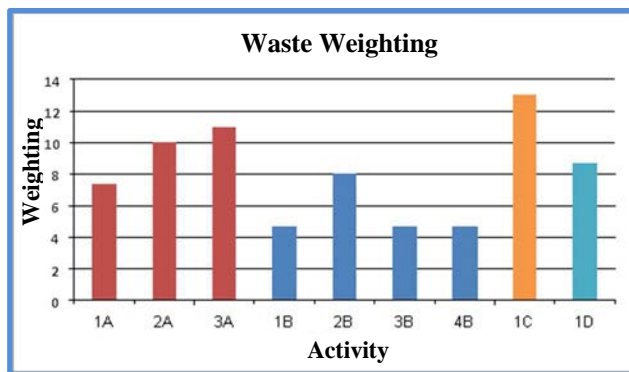


Figure 2 Critical waste weighting

Based on the graph above, it can be seen that the total average weight of the waste waiting is 28.33, then the total average weight of the unnecessary motion waste is 22, then the total average weight of the overprocessing waste is 13 and the total average weight, waste defect is 8, 67. It can be seen that waste waiting has the largest average weight with a total of 28.33.

3.4 Root cause

The problem-solving concept used in this research uses a Fishbone Diagram which is useful for finding the root of the main problem, namely Waiting Time.

1. Man Factor

a. Waiting for the arrival of workers, the lack of coordination between the foreman, labour foreman and other workers causes workers to often arrive late during shift changes and during breaks, the arrival of workers one by one causes workers to sometimes not be available to work immediately. This has a direct impact on the delay in unloading activities.

2. Machine Factor

a. Waiting for scouts/tugs, scouts/tugs are often not available due to the demand for the use of scouts/tugs at the same time, while another reason is the lack of available scouts/tugs causing ships to wait a long time and the incoming and outgoing flow of the pier to be hampered.

b. Waiting for the arrival of trucks, the minimal number of trucks available and the large number of simultaneous use of trucks at other loading and unloading companies (PBM) are the reasons why tapioca unloading activities have to wait for the unloading process to be carried out on trucks. Another cause is the lack of maintenance and regular checks carried out by the truck provider which causes trucks to often break down and have trouble, resulting in trucks often arriving late.

3. Factor Methods

a. The sacks fell and were torn, the piles were too high and too heavy to cause the sacks to fall and tear when they were lifted using a crane and when they were unloading the load on the truck, this was because the workers were chasing production targets. A pile that is too high and too many causes the sacks to fall and tear frequently, if this happens, rework will be carried out, as a result, the work takes longer and requires more energy [11,12].

3.5 Proposed problem fix

Based on the cause analysis that has been described using a fishbone diagram, Table 2 shows the result of problem solution for the company:

Table 2 Recapitulation of suggestions for repairing problems

The main problem	Sub Problem	Repair
Waiting time	Waiting for the Arrival of Workers	Coordination
		Labour performance evaluation
	Waiting for the Guide/Tugboat	Increase the Number of Fleet
		Adding Ship Master
Waiting for Truck	Increase the Number of Fleet	
	To do	
The sack fell and was torn	Maintenance regularly	
	Supervise	

In addition to fixing the main problem in waiting time, other improvements that can be made to minimize the types of waste other than waiting time to improve the process, including (Table 3):

Table 3 Fixes for other types of waste

Types of Wasting	Troubleshooting
Defect	Supervise and evaluate the performance of workers
Overprocessing	Supervise and evaluate the performance of workers
Unnecessary Motion	Mark the unloading area
	Add lighting facilities
	Supervise and evaluate the performance of workers
	Tallyman gives the bill directly to the driver

3.6 Future state mapping

The following is a description of the prediction of the future state or condition of the supply chain system from the unloading process flow of tapioca (Figure 3). The conditions in the value stream mapping are the results of predictions (not yet implemented by the company) which are expected to reduce the waste that occurs.

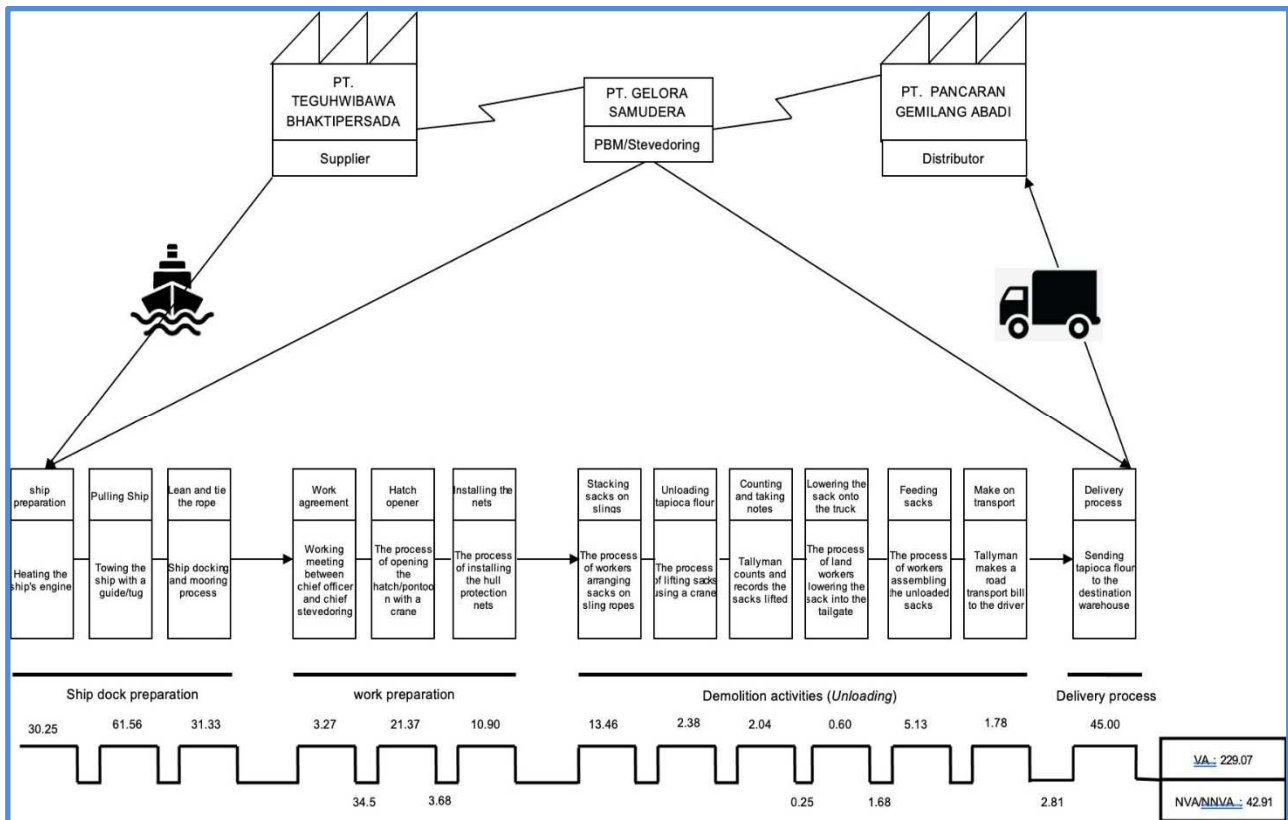


Figure 3 Future state mapping

Future State Mapping provides an overview of the new process flow, namely after the proposed improvement, where the time for activities that are not added value but are processes that cannot be eliminated, have been reduced and have discarded processes that are considered unimportant. By looking at the Future State Mapping in the picture above, it can be seen that with the proposed improvements, it is able to reduce the time of non-value-added activities by 59.62%. It is known that based on the Current State Mapping that has been discussed, the amount of time from non-value added (NVA) is 106.27 minutes, and the future state mapping can be reduced to only 42.91 minutes. However, this condition is only a prediction because the proposals given have not been implemented by Gelora Samudera Company itself.

3.7 Process cycle efficiency

Process cycle Efficiency (PCE) is a comparison between Value Added (VA), Necessary Non-Value Added (NNVA), Non-Value Added (NVA) and Total Lead Time or cycle time. Based on the data above, the PCE calculation is as follows:

a. Before repair

$$\text{Process Cycle Efficiency (Before)} = \frac{\text{Value Added Time}}{\text{Total Lead Time}} \times 100\% \quad (2)$$

$$\text{Process Cycle Efficiency (Before)} = \frac{229.07}{335.34} \times 100\%$$

$$\text{Process Cycle Efficiency (Before)} = 68.30\%$$

b. After repair

$$\text{Process Cycle Efficiency (After)} = \frac{\text{Value Added Time}}{\text{Total Lead Time}} \times 100\% \quad (3)$$

$$\text{Process Cycle Efficiency (After)} = \frac{229.07}{271.97} \times 100\%$$

$$\text{Process Cycle Efficiency (After)} = 84.22\%$$

Based on the results of the above processing, it can be obtained an initial comparison (Table 4) with the proposed improvement which can be seen in the table below.

Table 4 Comparison of initial before and after improvements

Indicator	Before Improvement	After Improvement
PCE	68.30%	84.22%
VA	299.07	229.07
NNVA	84.16	42.91
NVA	22.11	0
Cycle Time	335.34	271.97

4 Conclusions

This study concluded that there were several wastes that did not provide added value to the tapioca unloading activity process, namely waste of waiting (waste caused by the waiting process), including the following: man factors such as waiting for the arrival of workers, machine factors such as waiting for pilot boats / tugs and waiting for trucks to arrive and methods factors such as sacks falling and torn.

From the results of data processing, the total processing time of 32 activities and the total time of the entire process is 335.34 minutes after repairs can be reduced to 21 activities and the total time of the whole process is 271.97 minutes. PCE initial conditions were the total processing time from 68.30% increased by 15.92% to 84.22%, the VA value remained the same at 229.07 minutes, the NNVA which was originally 84.16 minutes decreased to 42.91 minutes, the NVA which was originally 22.11 minutes was removed.

The improvement proposals given to reduce and eliminate waste that exist in the process of unloading tapioca activities include the man factor, namely by coordinating and evaluating the performance of workers, from the machine factor, namely by increasing the number of pilot / tugboat fleets, increasing the number of ships. pilot/tug boat captain, increase the number of truck fleets and carry out service and maintenance regularly and the methods factor, namely the foreman must supervise to minimize errors made by workers.

Based on the research that has been done, the researcher feels that there are still many shortcomings, therefore, the following are suggestions that are expected to be input in an effort to reduce waste in the future and to be able to develop and use new methods which can vary other methods to analyze and identify the types of waste found in the process of unloading tapioca. In addition, deeper waste analysis including the distribution process until the goods arrive at the destination warehouse.

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Assessing carbon emissions reduction by incorporating automated monitoring system during transit: a case study

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Abstract: The green concept in operations is becoming an inevitable part of global maritime logistics activities and has an important influence on the improvement of efficiency and environmental performance. This paper aims to assess the continuous monitoring and tracking of container shipments at the ports in order to reduce carbon emissions thus improving environmental performance. In this research, near real-time RFID data tracing and tracking container cargo are shared by the automated monitoring system. The collected data gathered via digitalization is further analyzed to ensure a greener maritime logistics system. The significant findings of the study for the literature show that the actual fuel consumption is reduced when automated monitoring systems are used at the ports (Ports and CFS (Container freight station)). The reduced fuel consumption during the transit between the ports and CFS has resulted in a reduction in carbon emissions of environmental performance. The results show a 6 % reduction in emissions from port to CFS and 23% from CFS to ports. Thus, effective practices in Green Logistics are considered to be beneficial for carbon emissions. These findings contribute to the understanding and development of effective strategies for logistic operations using technologies to create a green performance. The study was performed in a certain set of environmental dimensions and the results may vary depending on the organization, which can be studied further in future research.

1 Introduction

Maritime Logistics is the foundation of national development and economic growth. India's freight transportation is likely to be approximately USD 150 Billion [1]. The transportation sector, including both road and maritime, is expected to rise thus, Global Maritime Logistics would have an impact on the world economy. 80% of the amount of world merchandise trade is borne by ships and a high proportion of developed countries' trade is also carried by ships [2]. In India, transport and logistics expense is 14% of its GDP, as opposed to 8% to 10% of the GDP for developed countries [3,4]. International airfare in India has further risen in the past ten years. The major issues for the high cost of transport in India are maritime logistics inefficiency and delays. Ports contribute effectively to the nations and global economy [5]. As ocean ports across economies transact cargo and constitute 80 % by volume, similar are the effects due to carbon emissions emitting 940 million tons of carbon dioxide per annum [6] and this quantum is expected to increase with the growing volume of trade [7].

Therefore, these inefficiencies occur as a result of the lack of proper basic infrastructure, lack of tracking and monitoring systems, lack of protection, and excessive fragmentation of the logistics industry. Contemporary technologies allow logistics processes to change the traditional way of functioning [8]. Maritime logistics will

play a major role in the future economic growth of developing countries. It is important that their work needs to be productive and properly organized to support the increase in trade and GDP. Rao et al. say that the implementation of environmental principles can be an advantage in maritime logistics.

Managing the efficiency and productivity of the port is a vital factor in today's economy. Monitoring maritime logistics can forecast shipping routes and delivery times more accurately. The logistics monitoring system has advanced considerably since the comprehensive developments in computer technology and information systems.

Emerging technologies such as big data analytics, the Internet of Things, and cloud computing boost consistency and responsiveness [9]. When these technologies are evaluated in terms of climate, they help to minimize carbon emissions. GPS-enabled navigation and Internet of Things (IoT)-based devices can effectively assist the logistics industry to track efficiency since they can be used to optimize routes. Indian logistics companies need to use new technologies in their green logistics strategies.

In recent years, technology has offered a great opportunity for the logistics industry at ports, particularly in India, to address the environmental considerations at sea. Due to the absence of information systems in India for tracking marine containers, here is a case study of container

transportation in ports through IT-based devices. The results of the study will be used to inspire other maritime logistics companies to use new technology to ensure green logistic operations at the ports.

After that, the rest of the paper is structured as follows. Section 2 briefly presented the literature review on green maritime logistics, the application of information technology, and performance management. Section 3 discusses the methodology of the research study. Furthermore, section 4 gives the case study of the research and the mathematical analysis. The conclusion deals with the findings, study management, and future.

2 Literature review

As a whole, the global maritime market is demanding. Since 1997, the International Maritime Organization (IMO) has been active in controlling shipping pollution. However, there have been some improvements on that front. In 2008, the Marine Environment Protection Committee (MEPC) of the IMO adopted amendments to the Regulations of Annex VI of the International Regulations for Preventing Collisions at Sea (MARPOL) that deal with SO_x and NO_x pollution.

On the GHG front, shipping is still not the responsibility of the United Nations Framework Convention on Climate Change (UNFCCC). Shipping is the top energy-consuming transportation and the top major polluter in the world [10]. According to a report from the Intergovernmental Maritime Organization, ships' sulfur dioxide emissions will cause more than 570,000 additional global premature deaths [11]. Recently, being "green" has become very common for maritime shipping due to the lack of harm to the environment. The research combined several sources of knowledge to estimate the exhaust emissions of ships [12].

In the modern world, ship speed is a major factor in traffic flow and environmental pollution. The development of a ship traffic emission model is a high spatial-temporal resolution for evaluating ship emissions. A research study produced results on the carbon emission of a leading shipping line while evaluating their network and its implications on marine policy [13]. The study identified the results of regions and ports of the east-west corridor. Various research studies have researched the EU emissions trading system (ETS) [14-17]. The European Commission proposed and defined the scope of ETS (Emissions trading system) for the emissions from the maritime sector [18].

The models considered the various vessels, operating modes, discharge equipment, time, and location. An analysis of the efficacy of the green flag incentive program and the effects of activities on vehicle fuel consumption and emissions in a port city is presented in [9]. The study suggested that implementing reducing speed and fuel transfer, decreased CO₂, and SO₂ emissions effectively. Moreover, to provide environmental protection, such regulation would affect the strategic decision of shipping lines. The econometric study showed the possible expense

of pollution control and calculated its monetary benefits. The largest net profit of this new insurance is 1 billion euros a year, and the equivalent gross expense is 230 million euros a year.

The author suggests that the adoption of a reduction of speed and fuel transfer as a green strategy could result in pollutant emissions decreased and possible monetary incentives for the shipowner. This is done to study the relationship between rates, costs, and efforts of green in maritime shipping. According to the research, there are substantial reductions in the sum of CO₂ emissions from steaming slowly relative to high-speed container transportation [19].

A proposition of a quantitative model to measure the voyage cost and landed logistics cost for carriers. The results of the analysis provide all sides with guidance for negotiation [20]. Several researchers have argued that the influences of competition, trade patterns, distribution of economic activity, product styles, and consumer strength are central elements of the shipping market. Another research explored the influence of the dynamic shipping industry on the distribution of trade and the level of economic activity [21]. To devise pollution reduction strategies, the baseline and projected output of pollutants, such as baseline and future emissions, are estimated in emission inventories.

Emission accounting is a policy instrument to rate goals for pollution reduction. Emission estimation models have been used to assess the possible environmental impacts and expense of mitigating risks. A port case study suggests that the supply of berths is crucial in their staterooms case study. There are experiments in which the findings were obtained by the reduction of the shipping speed to improve air quality and lower the emission of toxins [20].

Global AIS data combined with data about vessel characteristics was used to establish comparable vessel environmental indices (EIs) for major Chinese ports [20]. They listed many applications of IoT to enhance port operations, including RFID containers, electronic seals, port equipment condition tracking, engineering equipment asset management, and wireless automatic meter reading. Various research studies have emphasized reducing the impact of emissions by introducing logistics platforms for tracking and monitoring [22-24].

The research emphasized the role of IoT in ports to minimize out-of-date data collection, improve productivity in data collection, and ensure the immediate transmission of such data [25]. These authors identified an overall architecture of such a new generation of ports based on a series of Management Systems (MSs): intelligent planning system, intelligent warehouse system, intelligent vehicle (container) system, smart ship system, electronic monitoring network, and regional data center. The research identified that logistics was a priority sector that required growth. It was shown that there is a correlation between environmental and economical degradation and good green logistics performance in the Asian region.

The green maritime logistics sector will encourage economic development because it will help save money and the energy of the countries. Transportation activity has a significant impact on efficiency enhancements in green logistics. To reduce the effect of globalization problems, the performance management of green logistics activities is very vital [26]. The change in the logistics sector would further lead to a lower carbon footprint. It is challenging to provide green and cost-effective services of logistics when adequate monitoring is not performed.

The lack of implementation of new technology is reducing the effectiveness of logistics services. A study by Z. Bendiabdellah et al. [27] proved the effectiveness of the technology Vehicle to Grid (V2G) which can inject the power contained in the batteries of the electric vehicles (Evs) into the smart grid and thereby control the CO₂ emissions.

Green logistics management ensures that all logistics facilities and operations are handled under sustainability, with environmental issues considered. A major obstacle to logistics resource management systems is the issue of collecting real-time information on logistics infrastructure. Data obtained are either manual or computerized data.

There has to be robust knowledge sharing for Green maritime Logistics management. The given research has found a lack of awareness and the unregulated ability of trackless vehicle systems. Lots of transportation shipments are tracked and handled, globally. They built a foundation for monitoring and tracing activities and have more influence on logistics.

There are difficulties concerning tracking the efficiency of various green practices during the transportation of goods from port to CFS and from CFS to port. The role of green logistics monitoring and management in the future demand equal attention. This field requires research but is lacking in several aspects.

3 Methodology

This research aims to assess the influence of process automation (namely the introduction of RFID) on the reduction of carbon emissions and to propose the approach for automatization of data gathering and monitoring of container cargo. The operational process of cargo tracing and tracking was discussed with the practitioners and experts in the field, considering also the environmental compound of the process. The objective of the discussion was to understand the nature of container tracking operations by port operators for a check on transit time and dwell time of containers, that is directly or indirectly impacts carbon emissions as well. The challenges were considered together with the data comparison of the Logistic data bank project reports of the port industry in India.

As one of the solutions RFID implementations were considered the major technology for monitoring the process of container movement. Considering the lack of information on the data sharing in port the qualitative

approach was chosen to provide a better understanding of the problem [28], as it could reveal new perspectives from the environmental point of view. The research comprises two parts: the first part is an interview with practitioners and experts of the port industry; the second is the case study of the data available from the Logistic Data Bank. The interview process comprised semi-structured in-depth interviews based on the snowball approach for discussion. This approach is one of the techniques which enabled researchers and responders to evaluate the response to specific questions and subsequently converse with other respondents while enabling a wider discussion on the topic.

In total there were eleven experts that took part in the interview. The choice of the participants was based on their deep knowledge of the practical side of the problem of congestion of containers and the influence of this congestion on the environmental aspect. The experts represented sectors such as ports, freight forwarders, and IT implementation partners for tracking, along with secondary data from data bank reports. The respondents comprised of hierarchy from directors, managers, and executives across management and operations. The specific set of questions focused on the importance of tracking, and monitoring transit time, dwell time, its management, and scientific impact on carbon reduction while keeping the climate protection goals of the port and country (if any). Subsequently, apart from controlling carbon emissions, other benefits that respondents utilize and foresee for an automated container tracking system. All the questions while interviewing focused on the automation of container tracking while digitizing documentation, notifications, payments, process transparency and customer experience. While respondents were encouraged to share their views, the technique assisted researchers in collating data across the board of container transportation management. The second part of the research consisted of the analysis of secondary sources and Logistic Data Bank project reports. The main idea was to identify the influence of the usage of automatization on the congestion at gate ports and, thus, on the environmental compound. Data analysis was based on the open, axial and selective coding technique [29], which was used to overcome the challenges of the analysis of unstructured data and to maintain qualitative consistency and structure.

4 Results

This section represents the detailed overview of the qualitative study along with the condensing of interview responses, represented in a summarized form (Table 1). The section also illustrates the calculation of carbon emissions through automated tracking data and producing results. Briefly, the study of a single tracking platform for container visibility logistics data bank along with analysis is briefed.

4.1 Qualitative study and data analysis

Data sharing through the tracking and tracing process supports the seamless data exchange between various container stakeholders, thus enabling terminal authorities, container freight stations, transporters, ship liners, and customers to share the data and identify the near real-time location of the container. This assists in responding quickly to any critical situation and leads to minimal waiting at gates and in transit for container movement.

This qualitative study data analysis was performed while evaluating the unstructured interviews performed utilizing the open, axial and selective coding techniques. This method is primarily selected to maintain the

qualitative nature of evaluating tracking and its impact on carbon emissions. This method also assisted in overcoming the challenges of structuring and analyzing large unstructured interview data. Responses that were open-ended were analyzed by mapping and refining excerpts into categories for similar conceptual alignment. This process is supported in deriving relations while analyzing the data results and reducing them into similar categories. These were labeled as first, second and third-order aggregates.

Table 1 illustrates the resulting data structure on first, second and third-order affordances and transformational aggregate along with environmental factors that result as the part of the port adopting tracking process for visibility and reducing congestion time and tracking.

Table 1 Resulting data structure on interviews (Source: Author)

First Order	Second Order	Third Order Aggregates	Environmental Factors
Tracking and Tracing Electronic Notifications	Automation	Data Standardization	Yes
E-documentation. E-Payment	Process Management	Improved Efficiency	Yes
Congestion Management. On-time arrival of the container	Operations	Digital Innovation	Yes
Process transparency. Marketplace for truck management.	Innovation	Value added service	No
Customer notification. Availability of empty containers.	Customer Experience		No

Additional benefits of data standardization and efficient tracking benefits are as follows:

- a) Information exchange between multiple container stakeholders for operational efficiency and productivity.
- b) Congestion and delivery times of container, thus leading to a reduction in operational times and carbon emissions. Continuous tracking of container can lead to planning FIFO and LIFO strategies based on urgency of the cargo consumption at last mile user. With coordinated efforts performance parameters of ports, container freight station and transporter can be managed with effective control and better operations.
- c) Managing and reducing the dwell time of the container. Coordinated operations between difference stakeholders with continuous information flow leads to better planning and thus reducing the dwell time of container during storage and in transit operations.

4.2 Logistics data bank project summary and mathematical analysis

This section illustrates on the logistics data project brief, while explaining the importance of single window tracking system for benefits on operations and carbon emission control. Subsequently, the focus is given on

mathematically relating the reduction in transit time to carbon emissions calculation.

4.2.1 Logistics data bank project

Logistics Data Bank (LDB) is an information communication technology tracking solution that is dealing with supply chain stakeholders and provides tracking information [30]. The goal is to reduce transportation lead time and logistics costs by creating a system for tracking containers through the sharing of information in real-time.

The idea of Logistics Data Bank is to integrate and standardize the existing IT systems and provide a “single window”, thus managing the process effectively by helping in the visualization of container tracking from an end-to-end perspective. The process’s movement can be streamlined in transit and the result of visualized information can be analyzed in order to find the bottleneck of each entity in the supply chain. Visualization of the supply chain would lead to the enhancement of the process.

4.3 Carbon emission mathematical analysis

The mathematical calculation for the effects of carbon emission due to the reduced congestion in time by the automated monitoring system is performed in Table 2.

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Table 2 Calculation criteria (Source: Authors)

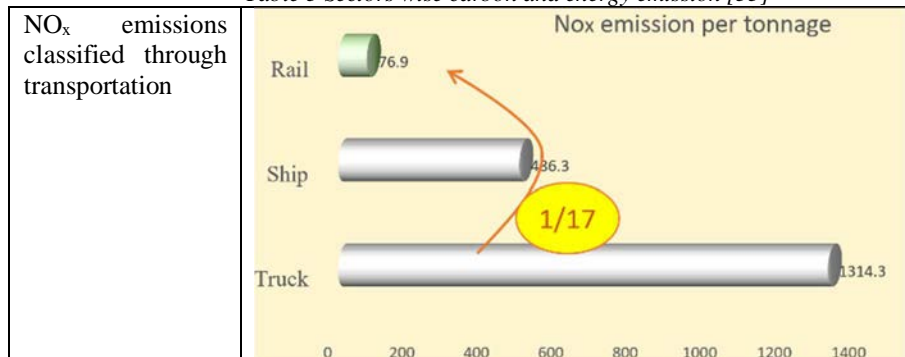
Calculation formula		$Carbon\ Emission = a * b * c$ (1)					
		<p>where <i>a</i> is the Average Fuel consumption per hour <i>b</i> is the Average Transit time (per hour) and <i>c</i> is Carbon emitted per litre fuel consumption (for diesel)</p>					
Vehicle	Gross Vehicle weight (tonnes)	Axle cong	Speed	Fuel consumption upper limit (l/100km)	Average fuel consumption (l/100km)	Average fuel consumption (l/100km)	formulation
N3 Tractor Trailers	40.2-49.0	6x2	40 km/hour	37.4	40	16 lr	Fuel used per hour = (Speed (40 kmh)*Fuel consumed (40lts))/(distance covered (10km))
	40.2-49.0	6x4		43			
CFS							
Import Cycle				Export Cycle			
Average distance covered by truck Port to CFS		20-Apr	21-Apr	Average distance covered by truck CFS to Port		20-Apr	21-Apr
19		2.4	2.3	19		4.8	3.7
Fuel consumed		39.12	36.8	Fuel consumed		76.8	59.2
Carbon Emission in Import Cycle				Carbon Emission in Export Cycle			
Formula	For Diesael (Kg CO2/ltr)	20-Apr	21-Apr	Formula	For Diesael (Kg CO2/ltr)	20-Apr	21-Apr
Carbon emission = Fuel Consumed * Fuel Emission Factor	2.9	113.4	106.7	Carbon emission = Fuel Consumed * Fuel Emission Factor	2.9	222.7	171.7
Assumption at that time	Assumption of truck/vehicle movement at a constant speed of 40 Kmph in the Indian scenario.						
Reference of numerical value	International Council on Clean Transportation (2017) [31] Cefic and ECTA, Carbon emission for diesel fuel, (2011) [32]						

The traveling time or transit time is calculated based on the analysis of the secondary reports of the logistics data bank project which provides the timestamp (location 1, IN time & location 2 Out time) between two location(s). This is calculated by the difference in the time stamp of location 1 & Out timestamp of location 2. This travel time constitutes all container trucks that have transported cargo containers between Mumbai-Delhi industrial corridor. Logistics data bank data and reports are in reference to all

the logistics container custodian stakeholders where RFID tags can be read, and the calculation includes Port Terminals, CFS's (Container freight station), toll plazas around JNPT port region & toll plazas on Maharashtra-Gujrat National highways.

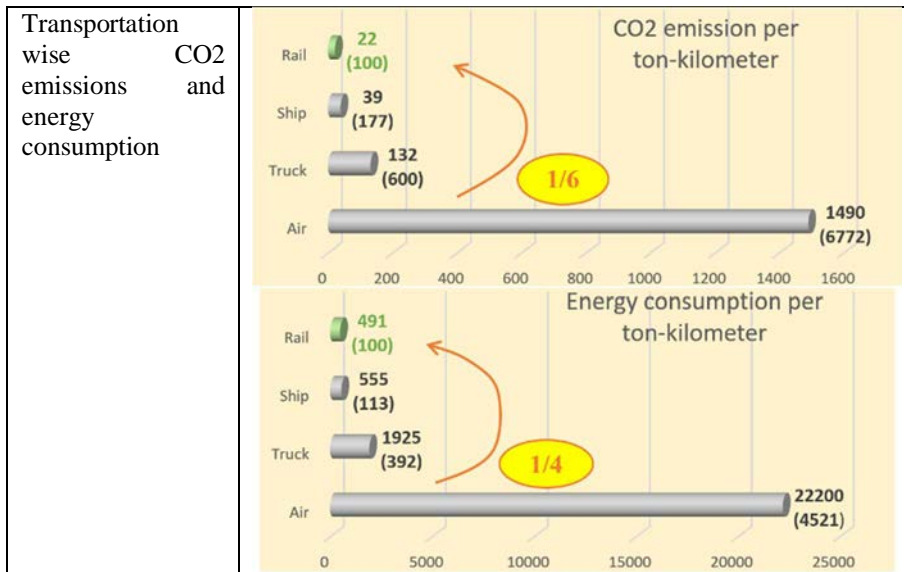
The calculation of Carbon emission for diesel fuel is referred to as per the report published by [32]. A detailed summary of the analysis of carbon emission and the energy consumption is illustrated in Table 3.

Table 3 Sectors wise carbon and energy emission [33]



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The analysis of the effect of the automated monitoring system is performed for two legs of container transportation. First the movement between port to CFS and afterward between in transit to toll plans for the onward delivery for the last mile. Figure 1 illustrates the reduction in transit time from 2.4 hours to 2.3 hours for Port to CFS and 4.8 hours to 3.7 hours for CFS to Port during the time

of 2019-2020 to 2020-2021. This has resulted in a reduction in carbon emissions from 113.4 kg CO₂ per liter to 106.7 kg CO₂ for Port to CFS and 222.4 to 171.7 kg CO₂ per liter for CFS to port. These reductions attributed to the reduction of 6% and 23% respectively in these two movements of container cargo.

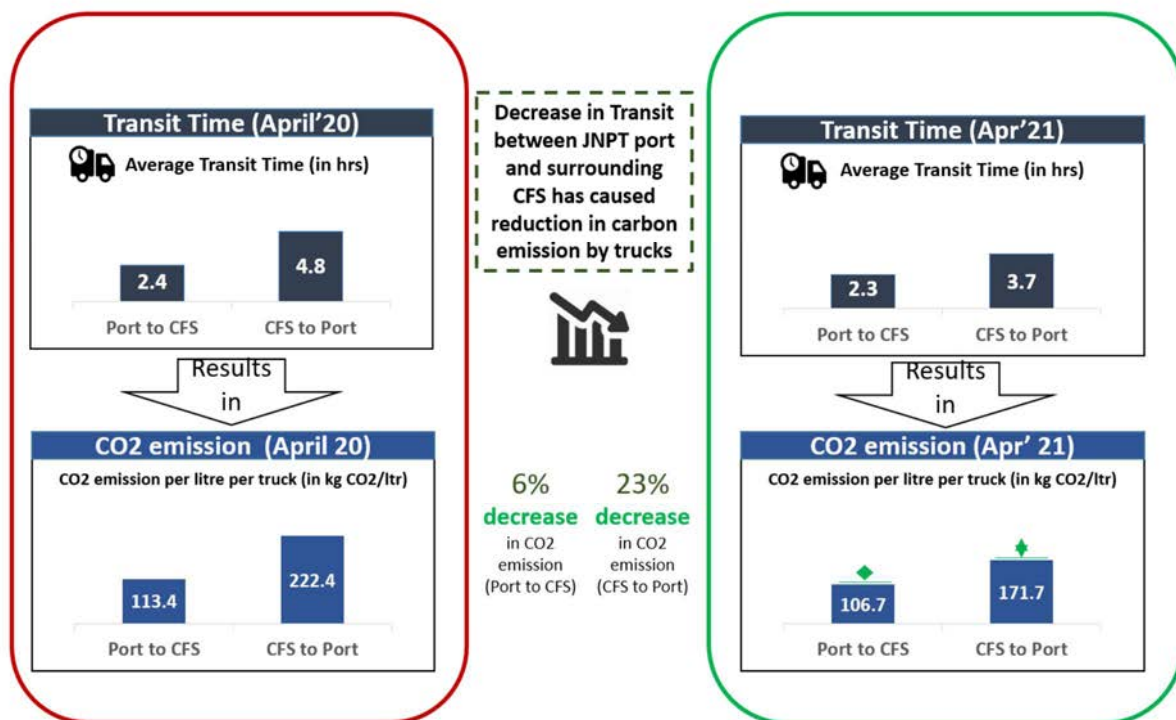


Figure 1 Comparison of reduction in congestion time through automated monitoring (Source: LDB Reports [34] and Authors computation)

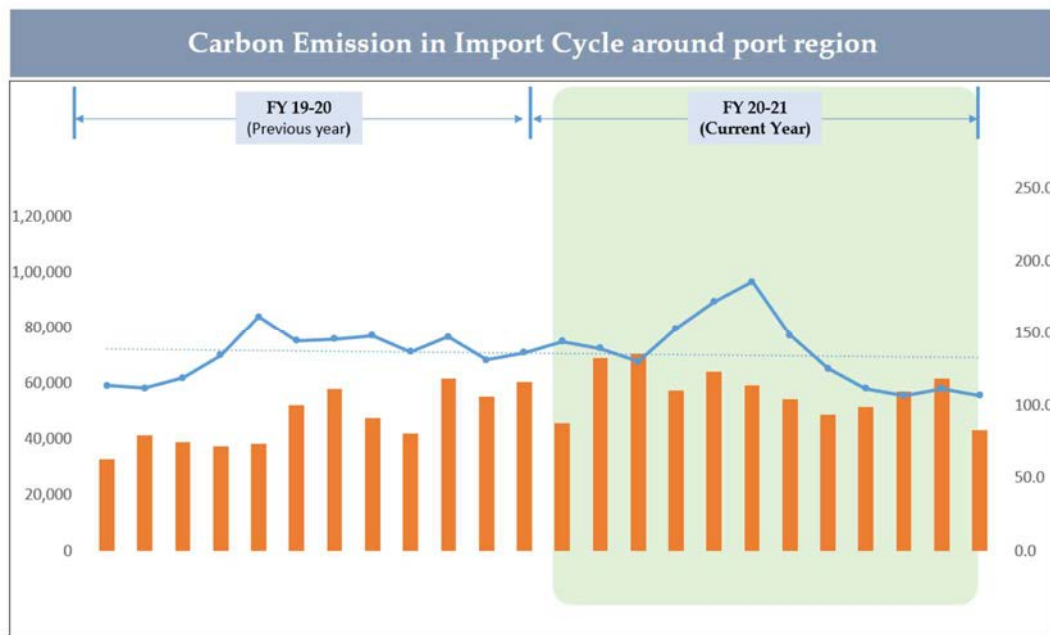


Figure 2 Annual comparison of carbon emission from Port to CFS (Import)
(Source: LDB reports [34]/authors computation)

Figure 2 illustrates the Carbon Emission during the import cycle between Port and CFS for the last financial year (FY 19-20 & FY 20-21) to observe the cyclical movement of container transportation during seasonal activity. The overall volume has increased in the year (FY 20-21) compared to the previous year (FY 19-20), however, the carbon emission has decreased by 6 % in the FY 20-21, due to the automated monitoring system

resulting in continuous tracking and reduced congestion during in transit.

Figure 3 depicts the Carbon Emission during the Export cycle between CFS and Port for the financial year (FY 18-19 & FY 19-20). The overall volume has increased throughout the year (FY 19-20) compared to the previous year (FY 18-19), and the carbon emission has decreased by 23 % in the FY 19-20.

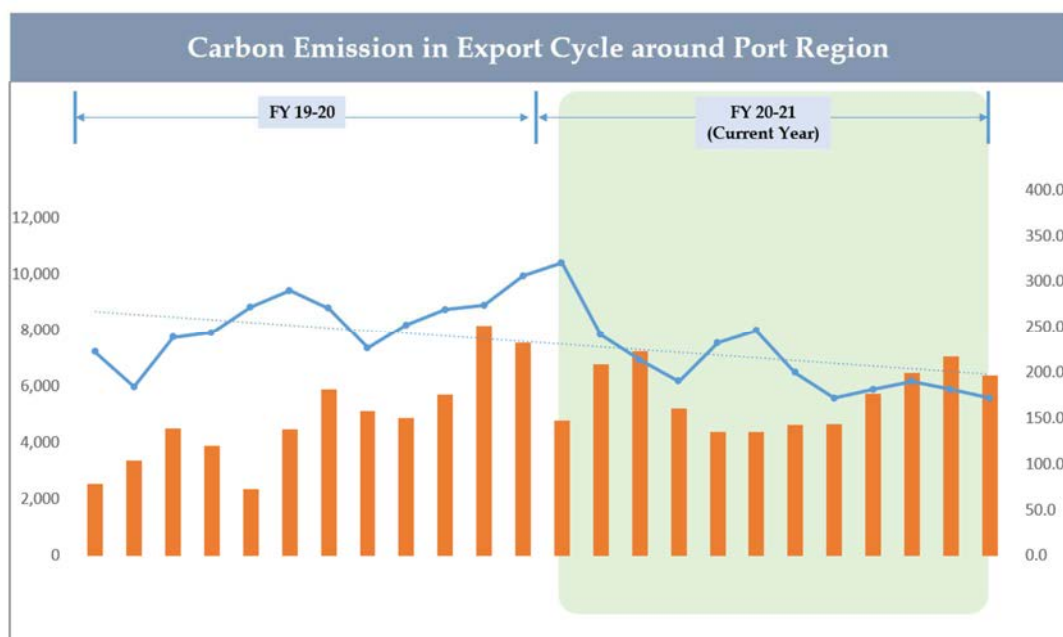


Figure 3 Annual comparison of carbon emission from CFS to Port (Export)
(Source: LDB reports [34]/authors computation)

Results displayed in Figures 2 and 3 illustrate that automated monitoring systems contribute to the reduction of congestion time and transit time of container cargo which is directly proportional to the reduction in carbon emissions during the traveling time of container cargo trucks.

5 Conclusion

Climate change across the globe is at the center stage for discussion at various strategic summits. This is primarily due to the growing demand for reduction in carbon emissions across sectors. This research study presented a mathematical analysis of the impact of the reduction in transit time and congestion time by an automated monitoring system in reducing carbon emissions. A case study of logistics data bank project is evaluated to present the effect of reduction in travel time of containers from Port to CFS (Import) and CFS to Port (Export). This travel time reduction leads to a reduction in congestion at gates and in transit, leading to a considerable decrease in carbon emissions.

It has been identified that implementing automated tracking and monitoring system for container movement between PORT and CFS leads to continuous tracking and, thus, positively influences the operational planning of cargo containers, as tracking and data storage can provide a better understanding of the current situation and contribute to the creation of the activities to desire the better results from the point of view of the creation of greener activities. This has led to a decrease in container cargo travel time from 2.4 hrs to 2.3 hrs for Port to CFS and 4.8 hours to 3.7 hours for CFS to Port. This reduction in container cargo travel time has led to a decrease in carbon emission from 113.4 kg CO₂/ltr to 106.7 kg CO₂/ltr from PORT to CFS and 222.4 kg CO₂/ltr to 172.1 for CFS to PORT. The results are significant to be noted as it has led to a decrease in carbon emission by 6 % in the Import journey and 23 % in the Export journey of container cargo travel time.

An analysis on a year-on-year basis illustrated a considerable decrease in transit time leading to a reduction in carbon emissions. This also contributes significant results on the mathematical analysis of the carbon emission reduction based upon the automated monitoring system management. The results show that an automated monitoring system is vital for the timely planning of cargo to reduce cargo travel time.

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Keywords: RFID robot, internet of things, logistics.

Abstract: The aim of this post is to point out the use of RFID robots in the management of logistics processes. RFID technology is defined first. RFID technology represents identification using radio frequency waves. The principle is to store the necessary data in radio frequency memory chips and then repeatedly read or write the data using a reader. We divide RFID chips into active and passive. Active RFID chips use energy from a battery, while passive RFID chips are a technology without an internal power source. Passive RFID is the most common form of RFID in warehouses, using which inventory is taken using RFID robots or hand-held RFID readers. Nowadays, many RFID robots from different manufacturers are available on the market. When choosing, I must consider where we want to use the RFID robot and choose the one that suits us based on its specific characteristics. The RFID robot is a mobile and autonomous RFID system that performs an inventory of the given space based on our initial setup. The RFID robot locates each item in 2 dimensions (x and y). Most robots can move in all directions because they can rotate without shifting. The accuracy of the inventory using the RFID robot ranges from 95-99%, while the accuracy of the inventory performed by employees using handheld RFID readers ranges from 85-95%. As for speed, it is on average 10 times faster compared to manual RFID readers.

1 Introduction

We live in a world full of smart devices. We have smartphones, smart home appliances, smart sensors, and many others. We could write this list for a very long time and will probably continue to increase. It is thanks to the engineers who design equipment using information technology. New electromechanical components now they can quickly process and calculate large amounts of data. Products made using this technology can not only fulfil their original role but can also do much more. By interconnecting smart devices, the world has become more accessible. Smart devices are used almost everywhere, making the Internet of Things popular with businesses and services in all industries. One of these technologies is radio frequency identification (RFID).

We have divided this article into two parts. The first part is devoted to the definition of RFID technologies and the classification of RFID tags and their advantages and disadvantages. The second and main part is devoted to the use of RFID robots in the management of logistics systems. In this section, you will also get information on the advantages and disadvantages of using RFID robots, which are then explained in the conclusion.

1.1 Internet of Things (IoT)

The term "Internet of Things" (IoT) was first used in 1999 by British technology pioneer Kevin Ashton to denote a system in which objects in the physical world could connect to the Internet using sensors. Ashton coined the term to illustrate the power of attachment of radio frequency identification tags (RFID) used in corporate supply chains to the Internet to count and track goods without the need for human intervention [1].

The Internet of Things (IoT) is a global network infrastructure that connects physical and virtual objects using data collection and communication capabilities [2]. It will offer specific object identification, sensor, and connectivity options as a basis for the independent development of cooperative services and applications. They will be characterized by a high degree of autonomy in data capture, event transmission, network connectivity, and interoperability [3].

1.2 RFID technology

RFID is an abbreviation of the English word Radio Frequency Identification, so it is about radio-frequency identifiers working in the high-frequency band. As one of the main areas of possible use, during the introduction of RFID technology, use as an alternative to the barcode was

considered. Compared to the RFID barcode, the technology offers higher scanning speed and easier deployment in automated systems. RFID elements and systems are most often divided according to:

- Frequency band.
- Type of identification element.
- RFID application.

Radiofrequency identification (RFID) - is used for automatic object identification and capturing data about that object that is stored in a small microchip tag and attached to the object. The RFID tag has a built-in antenna that communicates with the sensor a device that reads the data remotely. The data is then transmitted from the sensing device to the enterprise application software in which they are stored. Each RFID tag has its own unique identification number [4].

RFID can be used to record and control the movement of assets and employees. Tags You've probably seen RFID on the back of library books or even new books biometric passports [5].

1.3 Passive RFID

A technology without an internal power source that uses radio to send the signal waves created by the RFID reader. Passive RFID is the most common form of RFID in warehouses. In Table 1 we can see the advantages and disadvantages of passive RFID [6].

Table 1 Advantages and disadvantages of passive RFID

Advantages	Disadvantages
Low cost (~ €0.10 per label)	Expensive RFID signal readers are required
Small dimensions and weight	There is a short-range
Use up to 20 years	Unable to save memory

1.4 Active RFID

Technology that uses battery power to continuously broadcast a unique identifier label into the given reader. Active RFID is not as common in warehouses as passive RFID. In Table 2 we can see the advantages and disadvantages of active RFID [7].

Table 2 Advantages and disadvantages of active RFID

Advantages	Disadvantages
Long reading range	Higher costs (~ €20 per label)
Readers with lower performance	Battery life 3-5 years
They can have both sensors and data storage	Larger size and weight

2 Types of RFID systems

There are three main types of RFID systems: low frequency (LF), high frequency (HF), and ultra-high

frequencies (UHF). Microwave RFID is also available. Frequencies vary widely depending on the country and region [7].

- Low-frequency RFID systems. These range from 30 kHz to 500 kHz, though typically the frequency is 125 kHz. LF RFID has short transmission ranges, in general from a few centimetres to approximately 1 meter.
- High-frequency RFID system. These range from 3 MHz to 30 MHz, while the typical HF frequency is 13.56 MHz the standard range is less than 2 meters.
- UHF RFID systems. These range from 300 MHz to 960 MHz, with a typical with a frequency of 433 MHz and can generally be read from more than 7.5 meters.
- Microwave RFID systems. These run at 2.45 GHz and can be read at more than 9 meters.

2.1 Advantages of RFID technology in logistics

One of the most significant advantages of this technology is the possibility to assign a unique number for a specific assortment of items, which can be useful if your warehouse receives and stores goods from several suppliers at the same time [8].

In addition to a more accurate view of inventory status, RFID technology allows you to track average delivery times and track inventory in and out in real-time, which will help ensure the correct shipment of the item and reduce the number of product returns [10].

2.2 RFID robot

The fields of artificial intelligence, automation, and robotics scored in the last decades of tremendous growth and innovation. RFID inventory accuracy with handheld RFID readers could exceed 98%, but flawed procedures and human error reduce this accuracy to 85 - 95%. The RFID robot is a mobile and autonomous RFID system that automatically performs the inventory of a given space, for example, a retail store or a warehouse, which provides higher RFID inventory accuracy than handheld readers. Inventory accuracy ranges from 95 - 99%. It works completely autonomously: the user specifies when the inventory should be performed, and the bot starts when it is scheduled. RFID the robot also locates each marked item in 2 dimensions (x and y) [12]. This information is given to process to create a planogram of items inside the space. Information-generated RFID robots can be used to help employees detect wrongdoing placed items, to speed up the management of picking and returning goods, and for purposes of money mapping and other operational processes [13]. Most RFID robots can already move in all directions because they can rotate without shifting. Therefore, it can easily move around any space. Speed is synchronized with tag reading to maximize reading speed. The RFID robot contains: - an RFID system with a certain

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number of antennas, which depends on the size of the given RFID robot. Currently, there are several companies (see Table 3) that are dedicated to the production and provision of RFID robots.

Table 3 Producer and brand of RFID robot

Producer	Brand of RFID robot
keonn	Robin-200™
MetraLabs	TORY RFID
PAL Robotics	StockBot
fetch robotics	TagSurveyor
Simbe Robotics	Tally RFID

In Figure 1, we can see RFID robots from PAL Robotics, Simbe Robotics, and fetch robotics.



Figure 1 RFID robots

Each of the listed RFID robots (see Table 3) has specific properties that distinguish it from others. The biggest difference is how high it can scan RFID tags. Among others, the differences include autonomous navigation and obstacle avoidance, the possibility of autonomous docking and charging, the possibility to plan to scan routes, uploading data to the server customer in various formats, and many others [14].

Most RFID robots work on the same principle. We can summarize these principles in four points [16,17].

1. During the first operation in a new space, the RFID robot mostly moves around the space using the interface application. In this step, the RFID subsystem does not work.
2. This user-guided navigation allows you to automatically generate a map space. This mapping process needs to be repeated only if will significantly change the layout of the space.
3. The user plans when the RFID robot should perform inventories. For example, every day at 22:00. At the indicated time, the robot will begin to move autonomously around the space, reading and locating RFID tags and storing this information.

4. After it completes its inventory, it navigates back to its docking station to recharge.

2.3 Use of RFID robot in logistics

Poor inventory management is one of the distribution's biggest nightmares because it has a negative impact and means losses for the company due to incorrect data on stock and errors during transportation [19]. Using RFID robots allows us to get an overview of where items are located and how much stock is available to avoid pre-stocking and insufficient supply due to possible product losses. The use of RFID robots helps reduce the number of human errors that can have a significant impact on warehouse management. That also helps free up employees to work on higher-value tasks, such as optimizing warehouse management and providing better customer service.

The use of RFID robots in logistics brings many advantages, but also disadvantages, which are shown in Table 4.

Table 4 Advantages and disadvantages of using RFID robot

Advantages	Disadvantages
High accuracy	High entry costs
High speed	Interference
Multiple scanning	Data protection issues
Many formats	
Cost reduction	

It is clear from the table that the use of RFID robots brings us more advantages than disadvantages. The RFID robot can recognize and capture 98% of all products marked with an RFID label. As for speed, it is on average 10 times faster compared to manual addition supplies. It can also scan many more items at once compared to handheld RFID scanners. All scanned data is stored and sent to corporate information systems companies. The data is stored in various formats so that we can use it further. Since The RFID robot works autonomously, thus we can reduce labour costs.

A big disadvantage when implementing RFID technology and buying an RFID robot is that they are expensive entry costs, which will be returned to us over time. Another of disadvantage of using RFID in the robot may be the inaccuracy of the scanned data because certain materials such as heavy metals and radio wave sources can interfere with data transmission. The use of RFID technology and RFID robots can pose a data protection risk. These data will prove to us to be hacked by hackers. For this reason, it is very important to have well-secured data and invest in security software [20].

3 Conclusions

The main contribution of the article is defining the advantages and disadvantages of using RFID robots in the management of logistics processes. Currently, there are

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many companies dedicated to the production of RFID robots. Among the most famous companies that are engaged in the production of RFID robots are MetraLabs, PAL Robotics, Simbe Robotics and many others. Each one of the manufacturers specifies a certain type of RFID robot, according to its use. We can use them in retail operations, but also in large logistics warehouses. Each RFID robot has its own specific characteristics that distinguish it from the others. The main differences include the size of the RFID robot itself, the number of RFID antennas, the speed of movement, the speed of scanning RFID tags, the accuracy of scanning RFID tags, autonomous navigation and obstacle avoidance, the possibility of planning routes and several data storage formats.

The RFID robot is a mobile and autonomous RFID system that performs an inventory of the given space based on our initial setting, which we can adjust according to needs. During the inventory, the RFID robot locates each item in 2 dimensions (x and y), while all the information is stored and then we can use it for further processing. The accuracy of the inventory using the RFID robot ranges from 95-99%, while when inventorying by employees using manual RFID readers it ranges from 85-95%. This accuracy is lower mainly due to human errors or the use of faulty procedures. Another great advantage of using an RFID robot is the speed of scanning RFID tags, but also the speed of taking inventory. As for the scanning speed of RFID tags, it is 10 times faster compared to manual RFID scanners. Other benefits include multiple scanning, saving data in different formats, and cost reduction despite high input costs is very important.

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Optimizing internal transport in terms of technical parameters in a mining company

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Keywords: transport, machines, costs, reliability, innovations.

Abstract: The research scientific article summarizes the arguments within the scientific discussion on the issue of internal transport and machine park in mining companies. The machine park in mining companies is base of effective mining processes and optimal results of mining. The machine park in the mining company introduces a combination of stagnant and active equipment in the process of mining. The goal of this article is to reflect the innovative approach in the creation of internal transport by machine park in the mining company with the aim of increasing the reliability, safety, failures, and efficiency of mining equipment. The entity of the investigation was the selected mining company in Slovakia focused on limestone mining. Approach of research were focused on using comparative analysis of the technical parameters of mining machines and their technical performance. The relevance of the decision of this scientific research was connected with the innovation of a mining machine park focused on mobile machines with a combination of stationary machines. The article presents the results pointing to significant improvements in the machine park of the mining company. In this paper we suggest two alternatives (two models that monitor the factors as quality, costs, safety, reliability, and optimization of company resources, which are important for the optimal arrangement of equipments) of the composition of the machine park for a selected mining company with Mobil crusher Sandvik QJ341+, Mobile sorter McCloskey S130, Wheel loader CAT 972 M, and tracked excavator CAT 336F and second alternative Mobil crusher Hartl 12/65J, Mobile sorter Anaconda SR514, Wheel loader CAT 966 M and tracked excavator CAT 329E. The results of two alternatives of the machine park in a mining company can be recommendations for other mining companies in the area of building the machine park for mining processes and its optimization.

1 Introduction

The basic pillars of the “Sustainability” of mining processes are innovative approaches to the mining equipment, machines, technologies, and optimal application of the mining area in the synergy of the operation of the machine park for the internal transport of each mining company. The production cycle of limestone mining and processing is based on the efficient use of

production equipment in the individual processes of the mining life cycle (Figure 1). The mining company has realized production equipment for some main processes and the research was focused on helpful equipment used in the main mining processes. The main goal of this article is to point out the innovative approach in the creation of the machine park in the mining company with the aim of increasing the reliability, safety, failures, and efficiency of mining equipments.

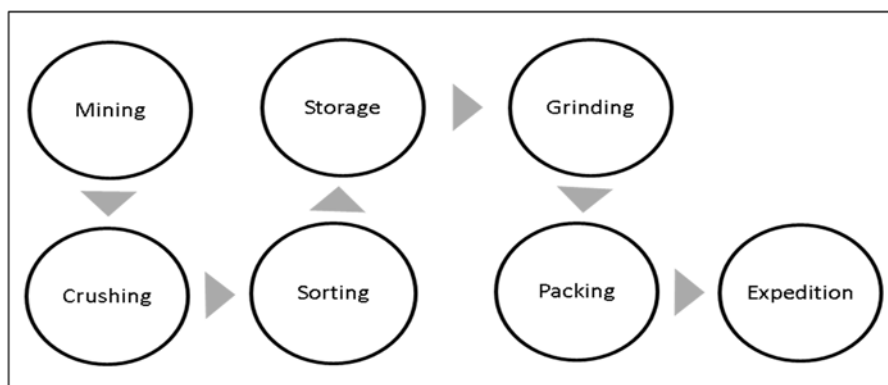


Figure 1 Main processes of limestone Mining (own source)

2 Literature review

Ambriško [1] and Grzegorzewka, Stasiak-Betlejewska [2] comment that the production potential creates indicators such as the number of machines, number of products, number of services, value of the gross value added, the price of buildings, the number and price of assets, the average level of employment, productivity growth, the value of the machine, the efficiency, profit, technical parameters, repairing, maintenance, modernization and others. Those indicators create a base for the value chain and for performance management in various enterprises in various processes [2]. Changing market requirements, pressure to minimize production costs, competition, but also legislative restrictions have an impact on mining processes and technical area of machine park in the mining companies [3,4]. Operational costs are very important part of the management of the machines and their performance. The main goal of mining company is minimize the operational costs. The one part of machine park is transport infrastructure and internal transport in mining company. This area create 20% costs of general costs of mining company and than is very important to solve transport and costs of machines park. Andrejiova, Kimaková [5] they indicated in the final study in their research that the transport infrastructure and the development thereof significantly affect performance of companies. The development of the transport segment is currently an essential process which affects industrial companies. The transport infrastructure and the services provided in this sector influence economic growth, the efforts aimed at increasing competitiveness, as well as prosperity of the society [5].

Machinery management (Figure 2) in mining companies is a major process focused on an efficient maintenance system.

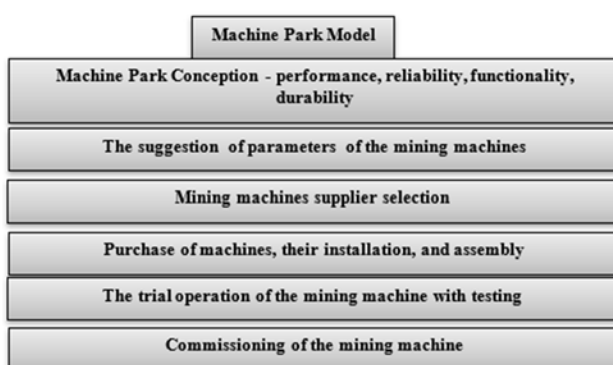


Figure 2 Machine Park model in mining company (own source)

The level of fleet maintenance has a significant impact on the performance of mining processes that are checked by performance indicators as index of efficiency, coefficient of function and other index of performance of technical state of machines [3]. The maintenance process according to the ISO 13306 standard is one part of process management and it is a prerequisite for performing technical, management,

and administrative activities during the life cycle of objects - machines and production equipment to fulfill the required function [1,6].

Process management can be provided by managerial instruments which are focused on special areas as maintenance. The most frequently implemented management approaches include: Supply chain management which is an important managerial tool determinant all conditions significant for suppliers and their use in praxis by the buying of machines in mining companies [7]. Maintenance management is focused on reliability, safety, functionality, reliability, quality, time, environment, and company costs [3,6]. Building a machine park in mining companies is the basis for the success of the mining process and very important part for financial page of the company. The Machinery park in a mining company stands on the financial plan which is creating one part of financial management. Financial management content is focused on the perception of the most important key factors of its sustainable effectiveness and performance in the context of its social, technological, and process aspects such as maintenance efficiency [8].

3 Methodology

In the scientific research of the mining company, we progressed based on the algorithm of steps (Figure 3), which was the principled tool for leading complex research in the mining company in area of machines. The subject of research was the machine park in the mining company for limestone mining. Many methods were used in solving the research, such as analytical, economical, graphical, and other.

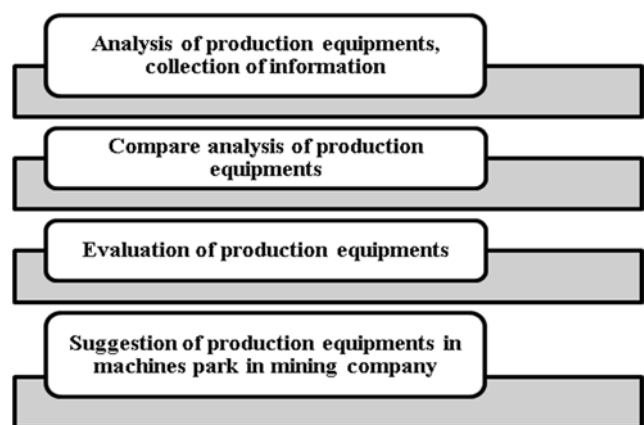


Figure 3 Algorithm of research in mining company (own source)

In this research, we dealt with the life cycle of production equipment in the phase of effective use in the mining process. By comparing analysis we watched the technical parameters of production equipment. The economic life cycle of production equipment in the phase of using means for the modernization, repair of production equipment, or buying new production equipment. The results of the research were the suggestion of production

equipment for a machine park in a mining company. Analysis of production equipment, collection of information - this step of the research was realized by a personal visit to the mining company. Comparing analysis of production equipment - consists of comparing original (past) and new equipment. Evaluation of production equipment - it consists of selecting the optimal production equipment for the machinery park in a mining company. The suggestion of production equipment in machine parks in mining companies - creates a model of using production equipment in machines parks for the life cycle of mining and its sustainability.

4 Results

Mining companies in the frame of innovation are using mobile machines with a combination of stationary machines. Mobile machines are bringing advantages for increasing demands of customers, for increasing volume of production-mining, for flexible reaction to market changes, and for an easier process of production [4]. The company's decision depended on increasing sales and insufficient production capacity in the process of crushing and sorting. The innovation process for the mining company meant buying new machines. The mining company bought a new mobile crusher (Figure 4). The significance of mobile machines is connecting to transport extracted raw material. In this way, the mining company is able to bring a mobile crusher, a mobile sorter directly to the excavated rock.



Crusher Hartl Powercrusher 12/65J



Crusher Sandvik QJ341+

Figure 4 Mobile crusher in Machine Park in mining company (own source)

Based on a comparison (Table 1) of the performance of the original Hartl 12/65J mobile crusher and the new Sandvik QJ 341+ mobile crusher, we can conclude that the Sandvik mobile crusher is more powerful to 50t/h for fraction 0-63 mm and 80 ton/h for fraction 0-100 mm. The mining company is able to use both crushers at the same time and thus produce more fractions of extracted raw

material. In the event of a failure of one device, the device will be replaced by another device without cessation of the crushing process. This machine is capacity reserve in Machine Park. This machine is capacity reserve in Machine Park. The capacity reserve in Machine Park in mining company is instrument for to block the mining process of reason no functionality of machine [9].

Table 1 Analysis of technical parameters of mobile crushers

Original machine		New machine	
Mobile crusher	Hartl 12/65J	Mobil cusher	Sandvik QJ341+
Machine performance			
fraction 0 – 63 mm	150 ton/h	fraction 0-63 mm	200 t/h
fraction 0 – 100 mm	250 ton/h	fraction 0 –100 mm	330 t/h

Source: (own source – research)

The mining company bought a new mobile sorter (Figure 5). As part of the mining company's machinery, it was also necessary to purchase mobile sorters as part of the following post-crushing process. Anaconda SR514 and McCloskey S130 mobile sorters sort the crushed raw

material into 0-10mm fractions, 10-32mm fractions, 32-80mm fractions and an oversized 80-130mm fraction. The introduction of new mobile sorters has increased the flexibility of processing the extracted raw material.



Sorter McCloskey S130



Sorter Anaconda SR514

Figure 5 Mobile sorter in Machine Park in mining company (own source)

The flexibility of handling mobile devices significantly facilitates the transfer of equipment and preparation for the processing process (crushing and sorting), which significantly increases overall productivity. Other equipment that is used in the mining process is wheel

loaders (Figure 6). Due to the mobile crushers and screens, it was necessary to add more powerful wheel loaders. The function of wheel loaders is to load trucks and fill hoppers that feed the raw material into mobile crushers.



Wheel loader CAT 972M



Wheel loader CAT 966M

Figure 6 Wheel loader in Machine Park in mining company (own source)

With the help of new wheel loaders (Table 2) with a larger spoon volume, the loading time of cars will be significantly reduced, thus speeding up the actual shipment and the continuity of the crushing and sorting process. The Dosan DL250 and Volvo L120E wheel loaders have lower

technical parameters than the new CAT 966M and CAT 972M wheel loaders. Operating weight is higher on 9200 kg for CAT 966M in comparing with Dosan DL 250 and 5900kg for CAT972M with comparing with Volvo L120E.

Table 2 Analysis of technical parameters of wheel loader

Original machine		New machine	
Wheel loader	Dosan DL 250	Wheel loader	CAT 966M
Operating weight	14 000kg	Operating weight	23 200kg
Spoon volume	2.5m ³	Spoon volume	4.4m ³
Wheel loader	Volvo L 120E	Wheel loader	CAT 972M
Operating weight	19 000kg	Operating weight	24 900kg
Spoon volume	3.3m ³	Spoon volume	4.8m ³

Source: (own source – research)

Spoon volume is higher on 1.9 m³ for CAT 966M in comparing with Dosan DL250 and Spoon volume is higher on 1.5 m³ for CAT972M with comparing with Volvo L120E. More powerful wheel loaders had to be evaluated

based on the volume of the bucket and the number of lorry. The following facts were found when comparing old and new wheel loaders (Table 3).

Table 3 Analysis of wheel loader

Wheel loader	Spoon volume	Number of lorry (24 ton)
Dosan DL 250	4.00	6.00
Volvo L 120E	5.28	4.55
CAT 966M	7.04	3.41
CAT 972M	7.68	3.13

Source: (own source – research)

The results of the wheel loader optimization show that the new CAT972M wheel loader is able to load a truck almost twice as fast as the Dosan DL 250 wheel loader, as the volume of its bucket is almost twice as large. As part of the optimization of the machinery in the mining company, it was necessary to purchase more powerful tracked

excavators (Figure 7) with greater weight and the associated possibility of a larger volume of bucket used, which allows you to use the capacity of production facilities to the maximum and reduce the time required to ship processed raw materials.



Tracked excavator CAT336F



Tracked excavator CAT329F

Figure 7 Tracked excavator in Machine Park in mining company (own source)

The function of the tracked excavator is to load the excavated rock into a mobile crusher. We analyse the technical parameters (Table 4) of tracked excavators in a mining company. We can see a comparison of original and

new crawler excavators. More powerful crawler excavators will ensure continuous production due to the constant utilization of crushers and shorten the interval of moving blasted rock from the floor to the crushing site.

Table 4 Analysis technical parameters of tracked excavator (own source – research)

Original machine		New machine	
Tracked excavator	Dosan DX 225	Tracked excavator	CAT 329E
Operating weight	23 600kg	Operating weight	30 500kg
Spoon volume	1.7m ³	Spoon volume	1.8m ³
Tracked excavator	Volvo EC290CNL	Tracked excavator	CAT 336F
Operating weight	31 000kg	Operating weight	27 200kg
Spoon volume	1.7m ³	Spoon volume	2.2m ³
Original machine		New machine	
Tracked excavator	Dosan DX 225	Tracked excavator	CAT 329E
Operating weight	23 600kg	Operating weight	30 500kg
Spoon volume	1.7m ³	Spoon volume	1.8m ³
Tracked excavator	Volvo EC290CNL	Tracked excavator	CAT 336F
Operating weight	31 000kg	Operating weight	27 200kg
Spoon volume	1.7m ³	Spoon volume	2.2m ³

Source: (own source – research)

The technical parameters of the new tracked excavators are reflected in the operating weight and spoon volume. Operating weight for CAT 329E is higher on 6900kg to Dosan DX225 and Spoon volume is bigger 0,1 m³ for CAT 329E. Operating weight for CAT 336F is lower on 3800kg to Volvo EC290CNL and Spoon volume is bigger 0,5 m³ for CAT 336F.

5 Discussion

The framework of the mining machine park and assess the technical level of the machines used affects the dynamics of volume of the extraction [10]. Very important part of the machine park is the technological safety of mining equipment. Dogan, Derya (2021) comment the technical and economical style makes it possible to determine the optimal structure of the mining equipments park, as well as to modernize the technology of the production process of extraction and to form appropriate mobile sets of machines for the extraction [11]. Mining organizations need to use different kinds of techniques and tools in order to fulfill their foundation goals of the mining process. In this aspect, using machine learning (ML) could be very helpful for dealing with challenges in mining. The parts of this machine learning technics created i.e., clustering, classification, regression, correlation, algorithms - i.e., support vector machine, neural network, learning types i.e., ensemble learning, deep learning, and performance metrics i.e., accuracy, mean absolute error which are connected with risk management [11].

Risk management in mining companies is an important part of quality management orientated to maintenance and creates the view for the use of lean management in the area

of the machines park [12]. Recent developments in smart mining technology have enabled the production, collection, and sharing of a large amount of data in real time. Therefore, research employing machine learning (ML) is very effective. Among the ML models, support vector machine was utilized the most, followed by deep learning models. The ML models were evaluated mostly in terms of their root mean square error and coefficient of determination [11,13]. In mining machine park is important to use new technologies. Currently, the global mining industry is seeing a growing interest in battery-powered electric machines, which are replacing solutions powered by internal combustion engines. Both machines were specially designed to substitute diesel machines in the conditions of an ore mine. They are the lowest underground battery-powered drilling and bolting rigs with onboard chargers. The machines can also be charged by external fast battery chargers [14]. Modern theories that make up the paradigm of sustainable development, and the best practices derived from them, are based on the consistency of individual and public needs, factors of economic growth and ecosystem protection [15]. Green economy expansion is moving from a challenge facing modern society to the dominant area of scientific thinking, which is increasingly focused on solving the problems of reducing the anthropogenic impact on the environment consist by mining activities. It is very important fact for mining companies to create machine park with machines focus on environmental sustainability [16]. The need to optimize the machinery in the selected mining company and the purchase of new equipment arose due to an increase in demand from the steel and construction industries to cover all orders from customers.

Optimizing internal transport in terms of technical parameters in a mining company
 Katarina Teplicka, Sona Hurna


Figure 8 New Machine Park in mining company (own source)

The first step in the optimization process was the decision to combine stationary and mobile equipment in the mining process. Mobile equipment with the ability to move in the mining area will save time and power for the processes of crushing the raw material and its sorting. Mobile crushers and screens purchased by the mining company for flexibility and simplification of the production process are used and bring benefits to the crushing and sorting processes. The mobile crusher and mobile sorter is able to deliver directly to the excavated rock, which represents flexibility and operability. As part of the optimization of the machine park, wheel loaders and

tracked excavators with better technical parameters were also replaced, which was reflected in the productivity of the mining process. The first alternative (Figure 8) for machine park in mining company is combination of machines: Mobil crusher Sandvik QJ341+, Mobile sorter McCloskey S130, Wheel loader CAT 972 M and tracked excavator CAT 336F. The second alternative (Figure 9) for machine park in mining company is combination of machines: Mobil crusher Hartl 12/65J, Mobile sorter Anaconda SR514, Wheel loader CAT 966 M and tracked excavator CAT 329E.

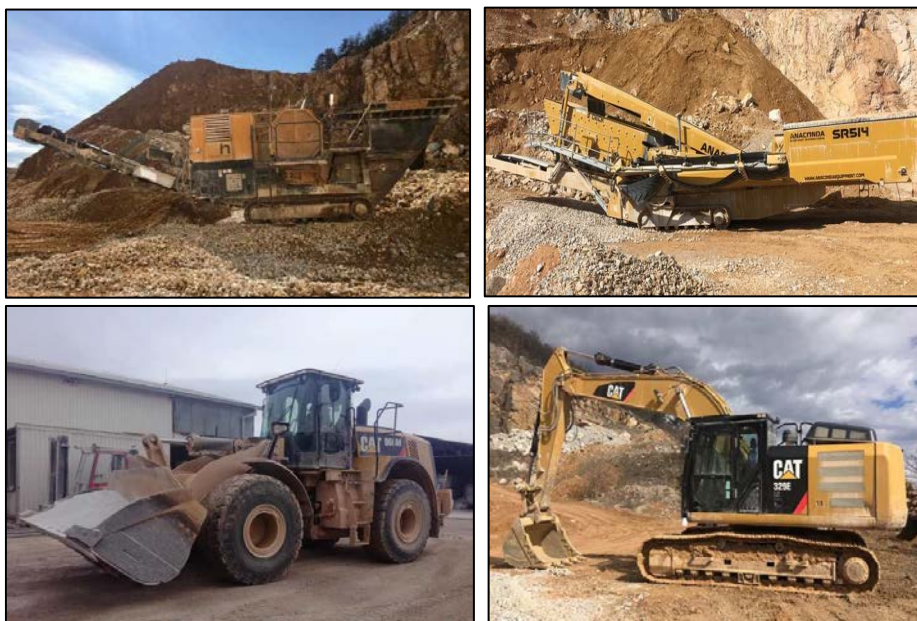


Figure 9 New Machine Park in mining company (own source)

The flexibility of handling mobile devices significantly facilitates the transfer of equipment and preparation for the processing process (crushing and sorting), which significantly increases the overall productivity. The property of flexibility is very important for a company in today's competitive market, the company needs to be able to respond quickly to market demands and produce a sufficient quantity of the required quality [17].

6 Conclusions

The necessary to optimize the machinery in the mining company and the purchase of new equipment arose due to an increase in demand from the steel and construction industries to cover all orders from customers. The first step in the optimization process was the decision to combine immobile and active equipments in the mining process that can be substitution in the mining space and in the mining processes. The main goal of this research and article was to point out the innovative approach in the creation of machine park in the mining company with the aim of increasing the reliability, safety, failures, and efficiency of mining equipment. The paper presents the results point to significant improvements in the machine park of mining equipments. Results of analysis were suggesting two alternatives of composition of machine park for selected mining company with Mobil crusher Sandvik QJ341+, Mobile sorter McCloskey S130, Wheel loader CAT 972 M and tracked excavator CAT 336F and second alternative Mobil crusher Hartl 12/65J, Mobile sorter Anaconda SR514, Wheel loader CAT 966 M and tracked excavator CAT 329E. Mobile crushers and screens purchased by the mining company for flexibility and simplification of the production process are used and bring benefits to the crushing and sorting processes. As part of the optimization of the Machine Park, wheel loaders and tracked excavators with better technical parameters were also replaced, which was reflected in the productivity of the mining process. The results of two alternative of machine park of mining equipments in mining company is the strategy of machine park for the future for many other mining companies.

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Impact of industrial free zones on the business environment of emerging countries

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Abstract: Free economic zones are one of the many ways for governments to alleviate a national crisis situation, by helping increase trade, enhance production, and create provisions of foreign direct investment. That can help in improving the economic condition of the country and enhance the quality of life of the country's population. Free economic zones, or free zones, in Morocco have also been established for similar reasons, and due to its perfect geographical location, has become one of the top priority destinations for regions across the globe for logistic purposes. To meet this objective, the reflection carried out at the level of this study turned towards the development of free zones in connection with the business environment in emerging countries, taking into consideration the case of Morocco, then it has a very strong logistical evolution as well as an exceptional geographical position for the improvement of its positioning in international competitiveness. This article presents the results of a quantitative study on the business environment of free zones in Morocco as well as on their economic impact aimed at improving the country's logistics level. This study aims to understand the theoretical and practical purpose of establishment of free zones in Morocco, their significance in the logistics industry, and their key advantages and challenges. This study provides a research background for industry practitioners and academicians of different regions alike to understand the use of Moroccan free zones to effectively strategize logistics decisions from a corporate standpoint, leading to better economic performance.

1 Introduction

International trade is now a real source of added value for customers, suppliers and businesses in the form of service reliability, performance, efficiency in terms of time and responsiveness while calling for an efficient logistics system. In addition, free economic and industry zones is the main place for the profitability of the company, through the process aimed at optimizing production capacities, stocks and costs.

In this perspective, this article attempts to identify in a clear and scientific way the impact of the economic and industrial free zones on the economy of a well-defined country, namely Morocco.

2 Materials and methods

In a research study [1], Morocco, due to its geographic presence in North Africa, has become an essential site for the major logistical and commercial processes between the west and the east of the world. The country is at the center of many international trade routes and links the United States, Europe, Africa and Asia. Many countries in these regions have invested heavily in terms of foreign direct investment and have been able to take advantage of Morocco's logistics industry to conduct their activities between the Eastern Hemisphere and the Western Hemisphere of the globe following a study [2]. The Kingdom of Morocco is only 14 kilometres from continental Europe, but far enough to become a stopping

point in front of the regions of Asia and Africa. Taking advantage of this opportunity, the government of Morocco has set up free trade routes through many ports in the country over the years to facilitate international trade [3]. However, the use of free trade must be observed and studied to allow a comprehensive understanding of how it can help companies that have logistical needs requiring a stopover or a need for transport through Morocco. The country is close to Europe, but the business practices, the establishment of rules and regulations, the payment of taxes and logistical costs, among others, are very different from the European and American modes and the needs must be assessed. In the Oxford Business Group Report [4]. In a research study [5] The Moroccan business style is quite different from the way trade relations develop in the European and American regions, and this business style should be studied to ensure the full use of the free zones of the Moroccan logistics sector. This study makes it possible to assess the Moroccan logistics industry and to understand the logistics and transport sector in Morocco for international business and international trade.

The aim of the study is to provide a basic understanding of the logistics industry in Morocco, with an emphasis on the evaluation of free zones within the kingdom. The methodology to achieve the objective of the study will be to examine the literature on the free zones of the logistics sector of Morocco through articles, syntheses and research which have been published in specialized journals, reports

on the sector. transport and logistics of the country, newspaper and magazine articles concerning industry, trade and transport across Morocco. Subsequently, we set up a quantitative study with companies in a few industrial free zones to understand their perceptions of the level of logistics, the business environment and overall performance.

3 Result and discussion

In the software industry, the developers will never state that the product is free of imperfections, dissimilar to other modern item makers generally do. This distinction is because of the accompanying reasons.

3.1 Presentation of the logistics sector in Morocco

The Moroccan economy is improving and, according to its annual growth of around 4%, the country is moving towards economic stability. Its political position and good geographical location are reasons which give it a competitive advantage compared to other North African countries. As a result, it is more likely to become a transition center in the logistics process for many companies in North America and Europe [6]. Foreign direct investment has led to the development of free zones for international companies. In addition, with the signing of free trade agreements with the European Union, the United States and Turkey, alongside the increase in per capita income, Morocco has become an enviable destination for international trade. The Moroccan government is also investing massively in the development of the country's commercial position, by promoting foreign trade through maritime routes. The government has developed and maintained more than 35 commercial ports in Morocco and has also spent around 3-4 billion dirhams to modernize these seaports. In addition to seaports, regarding a study [7] the government has also worked on the development of its road, rail and air network to improve its logistics sector. This has led to increased public sector investment in the development of physical infrastructure, thanks to which the country has evolved into one of the main transportation and logistics centers for North America and is striving to become an Essential "hot spot" for companies in the eastern and western parts of the world.

The average of import days in Morocco is 14 days, which is higher than that found in the countries of the Organization for Economic Co-operation and Development (where the average is 9 days), but well better than the rest of North Africa and the Middle East (where the average is around 24 days). This offers better opportunities to the Moroccan logistics industry. In addition, free trade agreements have been signed unilaterally or bilaterally with the European Union (signed in 1996, entered into force in 2000) and with the United States (signed in 2004 and entered into force in 2006), providing for the development of economic activities in

Morocco by companies from the EU and the United States [8]. Other agreements include the Morocco-EFTA Free Trade Agreement (European Free Trade Association), the Morocco-Turkey Free Trade Agreement for trade in goods and the Arab Free Trade Agreement for the trade in products from the Arab States with the exception of prohibited products regarding a study [9]. These agreements facilitate the conduct of business with very little or no intervention on the part of customers and generating very few commercial costs.

3.2 The current tax system in Morocco

The normal tax rate in Morocco is 30% and applies to both resident and non-resident taxpayers. The tax is applied territorially in the country and companies operating on Moroccan soil are also required to pay taxes on all income of Moroccan origin [9]. The country's tax system also allows for optional advance taxation, which represents around 8% of the contract value. In a study [9] Businesses must pay their taxes before April 1 of each year, and all taxpayers are also required to pay VAT on taxable transactions. With regard to expenses incurred by companies in the exercise of their activities, the tax is deductible if not otherwise specified regarding a study of [11]. For companies operating in free trade zones, the tax rate in Morocco is 8.75%. Corporate taxation concerns foreign companies more than businesses in the region. Moroccan companies have to pay 6 taxes a year, while companies in the Middle East and North Africa have to pay 17 times, American companies 10 times and German companies 9 times [10].

3.3 Key challenges in the implementation of free zones

Free zones present challenges that can threaten the effective use of their benefits. The most common challenges include environmental degradation, scarcity of resources and the mismatch between industrial and social development. In terms of environmental degradation, governments and companies generally abandon the environmental assessment when setting up these free zones, endangering the environment of the region [12]. In a study [19], Goodwill generally reflects the value of industrial assets such as brand awareness, good relationships with customers and employees, and proprietary patents and technologies, which allows for better economic improvement. This poses a long-term problem. Another challenge is the shortage of resources, which can occur if the balance between demand and supply is not properly assessed and if the country is not ready to meet the demands of the free zones [13]. In addition, Morocco could experience a delay in social development, which creates an imbalance in civil society, since the country's industrial development involves leaps and bounds due to free zones [14].

3.4 Impact of free zones on cost reduction

Free zones have substantial benefits for businesses, mainly financial incentives that help reduce costs. In a study [25], Industrial zones help simplify administrative procedures and save money because they encourage foreign ownership. During the last thirty years, important practices have been implemented to achieve an improvement in development, but also to acquire better adaptation, while bringing a real modernization of infrastructures [24], without forgetting the establishment of necessary institutional reforms. at the legislative level. Free zone regulations are relaxed and subsidized, encouraging companies to save despite long-term leases, expatriate employment or by exempting income taxes. Regarding a study [15], Morocco also offers a tax holiday option for companies of around 5 years. These benefits being very lucrative, the free zones are very popular and prosperous, especially in this country. Knowing that the level of competition with innovation in technologies and emergence of FinTech have gone higher [18].

3.5 Change in the face of the Moroccan industry after the establishment of free zones - specialty review

Research on this subject has made it possible to apprehend the free zone of Morocco (Table 1), more precisely the free zone of Tangier (TFZ). The country's free zone has created a different perspective on the traditional export process thanks to a multisectoral approach to development. The creation of this free zone dates back to 1999 and it was opened to operations from 2000. This free zone is located near the airport and covers an area of 345 hectares. Around 400 companies are operational in this space. In the Oxford Business Group. Report (2016) The users of this free zone of Morocco have invested roughly 500 million euros for their installations. The free zone has created around 40,000 jobs, the majority of which are held by Moroccan citizens, Oxford Business Group. (2016). This improved the economic conditions of these workers, while the free zone represented an increase in Moroccan exports to the tune of 1.2 billion euros, of which one tenth comes from the free zone. The Moroccan free zone has also led to the development of the logistics sector in this country, since many companies manufacturing components also require a transport service regarding a study [19].

3.6 Quantitative analysis: normality, reliability and regression test

Quantitative data from 50 employees of logistics companies in the Tangier Automotive city We then

analyzed the data using SPSS (v21.0) and Microsoft Excel statistical tools.

Descriptive analysis was performed for both demographic factors and logistic performance factors, including the test of frequencies, mean variance, and standard deviation. In addition, inferential analysis was performed which included normality test, reliability test, regression [21].

For the statistical analysis of the aspect of the study, the statistical precision must be taken into account. Statistical precision presents the narrowness of the margin of error in the study. For increased accuracy, a larger sample size is required. However, the accuracy slowly increases due to the square root of n in the denominator of the formula. Thus, to halve the margin of error, the sample size would have to be multiplied by four. The margin of error is also influenced by the level of significance or level of confidence, but this tends to remain fixed within a field of study. The inputs are the assumed or estimated value of the proportion, the desired level of confidence, the desired precision of the estimate, and the population size for bounded population sizes. The desired precision of the estimate (also sometimes called the allowable or acceptable error in the estimate) is half the width of the desired confidence interval. Statisticians use a confidence interval to express the degree of uncertainty associated with a sample statistic. A 99% confidence interval will be wider than a 95% or less precise confidence interval. Thus, in the present study, an accuracy of 95% was taken into account.

The importance of the "Cronbach's Alpha" reliability test consists in finding the internal consistency between the variables of the study. It is also done to check the interrelation between the variables of the proximity of the variables between them [17]. However, high reliability does not show one-sidedness of the variable and is simply a test to find the constant measure of a theory. In addition, another hypothesis test was performed to determine the validity of the collected and expected data. The hypothesis normality test was performed to assess whether the found dataset was collected from a normal distribution [16]. While performing a normality test, it is necessary to check whether the variables show a statistical test of "Shapiro Wilk (W)" less than "1", which can be interpreted in the sense that the observed distribution does not correspond to normal distribution [16]. It is also necessary to check that when the "W" value is small enough, the p-value should.

Table 1 Free zones operational in Morocco

Free zone	Activity area	Area (hectares)	Overall cost (millions of DH)	Jobs identified / Companies established in
Tangier (TFZ)	Automotive industry; aeronautics; agro industry; textile and leather; chemistry and parachemistry; metallurgical, mechanical, electrical and electronic industries; and services related to the above activities	45 (planned extension of 100 hectares)	740	44 210 jobs / 415 companies
Tangier Automotive City (TAC)	Mainly automotive sector; Other activities: agro-industry, textile and leather industries, metallurgical, mechanical, electrical, electronic, chemical and para-chemical industries	178	1 181,7	1,020 jobs / 4 companies (and 10 in the process of being set up)
Nouaceur	Mainly aeronautics and space industry; Other activities related to security and detection systems, medical industries and embedded metal, metallurgical, electrical and electronic industries as well as precision systems	78	887,6	5 companies (and 3 in the process of installation)
Kénitra	Automobile industry	199	1 214	11,245 jobs / 7 companies
Technopole d'Oujda	Equipment activities for sustainable development and the industrial professions of renewable energies and energy efficiency	6 (of which 40 completed)	160	
Tétouan-shore	Services: banking, insurance, accounting and finance, human resources, general back office, customer relationship management	6		
Casanearshore	Services: bank, crèche, shops, MedZ Sourcing One Stop Shop, restaurants	53		26,000 jobs (eventually) / 70 companies
Rabat Technopolis	Services: bank, crèche, shops, MedZ Sourcing One Stop Shop, restaurants	107		30,000 jobs / 76 companies
Fès Shore	Services: bank, crèche, shops, MedZ Sourcing One Stop Shop, restaurants	22		15,000 jobs
Oujda Shore	Services: bank, crèche, shops, MedZ Sourcing One Stop Shop, restaurants	22		2,000 jobs

Table 2 Shapiro-Wilk normality test for the collected data set

	Shapiro-Wilk		
	Statistics (w)	Ddl	Signification (p)
Performance level	0.867	50	0.001
Technical level	0.949	50	0.019
Organizational Level	0.984	50	0.009

Table 2 shows the Shapiro-Wilk normality test for respondents working in the Tangier Automotive city. The variables used for the normality test show that all other operational factors of the port are not normal. This is because the p-values for Technique (0.019), Organization

(0.009); are less than 0.05 and therefore do not show a normal distribution. Thus, from the normality test, it can be assumed that the collected data set does not have a normal distribution.

Table 3 Co-effectiveness of Cronbach's Alpha reliability

Cronbach reliability test		
Factors	Cronbach's alpha	Number of items
Technical level	0.885	16
Performance level	0.895	14
Organizational Level	0.848	09

The reliability test was carried out to check the stability and consistency between technical, organizational factors and the general performance of the companies. It was undertaken to determine the consistency of the data collected during the survey. Cronbach's alpha coefficients

as shown in Table 3 were found to be greater than 0.6; (0.885) for Technical, (0.895) for Organizational and (0.848) for global performance, thus showing a relatively high consistency. Thus, it can be interpreted that the factors are very stable and consistent.

Table 4 Model Summary of regression analysis between organizational performance and logistics operations

Model	R	R-R	R- R adjusted
1	0.955	0.927	0.810

The regression analysis between the different organizational services provided by the companies in the logistics zone of Tangier has been shown in Table 4. It is relevant from the regression statistical table that R-square of 0.927 or 92.7% and Adjusted R-square of 0.810 or 81.0% showed that for each logistics service factor indicates variation in overall operations. Thus, with the increase in the variables of the organization's performance factors, there will also be an increase in the overall operations at the level of the companies in the logistics zone of Tangier.

3.7 Discussion

The free zone has made it possible to develop seaports, roads and airports. The direct role of the logistics sector is reflected in its contribution to national GDP, which is 5%. However, the logistics sector plays many indirect roles in Morocco's economic development, which has been made possible only through the creation and development of the country's free trade areas. The success of free zones has also prompted the government to further develop the logistics sector by increasing port capacity, creating logistics free zones, building distribution infrastructure and developing dry ports and multimodal connections [20]. This is a very positive sign for the whole industry regarding a study [22]. Knowing that it is necessary today to systematize the applied concepts of economics and supply chain management following a study [23]. Thus, the creation of free zones in Morocco has led to long-term economic development and political stability in the country.

4 Conclusion

Free zones are very lucrative options for countries looking for foreign direct investment to strengthen their economic situation. Morocco used the construction of free zones to promote itself on the world stage in order to become a profitable destination for the start-up of companies and commercial and industrial operations by

many companies from the United States, Europe and Asia. Globalization has recently become a slogan which has boosted business investment in developing countries, particularly in Morocco. The free zone established in Morocco has thus been very successful and new free zones are being created. However, calling on investors for the development and initial launch of a free zone is a difficult and complex process, and the road to success is long. The creation of these free zones also helps a country to improve its economic score. For Morocco, the free zone has led it to maintain its political and economic stability for the past 15 to 20 years and has enabled it to become one of the most stable economies in the North African region. With regard to the future direction, it is very important to understand the pitfalls of free zones in order to be able to establish a global image of the economic zone.

In this study, the researcher focused on the impact of industrial free zones on the technological economy of emerging countries: the case of Morocco, he concluded that the establishment of free zones within any emerging economy will allow an improvement in the performance of the country but this through the technologies made available by the parent companies, and this has had a very positive impact on the performance of all the players, in this context it is strongly recommended to carry out similar studies on the possibility of emerging high technologies in emerging countries.

Regarding the difficulties encountered, since the free industrial zones are very far away, this forced us to work on the minimum number of cases due to the logistics of the study. As for future directives, our next research work will focus on the port performance of ports with direct connectivity to industrial free zones.

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The features of negotiations within reverse logistics cooperation

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Keywords: reverse logistics, cooperation, value, negotiations, dimensions of negotiations.

Abstract: The subject of consideration in the paper are negotiations between companies cooperating within reverse logistics. The objective of the paper is to present a concept for describing the specificity of such negotiations, influencing the ability of cooperating parties to create and recover value within reverse logistics. As introductory part of the article the methodology used for preparation of article is presented. Then, reverse logistics as the activity influencing value creation and value restoration is characterized. In next part of the work main units cooperating and negotiating within reverse logistics are distinguished. In this part the specificity of reverse logistics as environment for negotiations is also presented. Within the subsequent parts of the article in order to present the features of negotiations within reverse logistics cooperation the original methodological framework is applied, comprising the key aspects of negotiation's definition, distinguished on the basis of different approaches presented in literature, e.g. as a process, methods of conflict management and reaching agreement, mutual dependence of the parties and processes of: decision making, communication, mutual exchange and value creation. The summary synthesizes the major features of the considered negotiations, and also indicates the directions of research enriching the proposed concept. The approach to description of negotiations presented by the authors of the paper is a novelty and has an original character, i.e. it is based on their own thoughts on the specificity of the negotiations under consideration. No such concept has been presented in the literature on the subject so far.

1 Introduction

Integrating the cooperation of enterprises in supply chain is distinguished among the key factors enabling the achievement of competitive advantage and increasing performance effectiveness. In the supply chain, suppliers (of raw materials, materials, semi-finished products, parts), manufacturers, wholesalers, retailers, as well as providers of specialized logistics services cooperate with each other to deliver products to recipients.

In terms of the development of the concept of Green Supply Chain and Sustainable development, the companies operating in the field of reverse logistics are also of great importance. Reverse logistics is treated as important area of value creation and value restoration [1]. It is concentrated around three main directions of activity: recycling, reuse, remanufacturing [2]. Values achieved by the reverse logistics can be of tangible or intangible character [3-5].

Types of operations included in reverse logistics may be carried out by suppliers of specialized logistics services collecting waste and secondary raw materials, units disassembling used and damaged products, companies processing secondary raw materials, as well as companies dealing with final waste disposal. The issue of cooperation with service providers is treated as one of most important problems when managing reverse logistics [1]. Activities carried out by specialized service providers may be implemented separately but may also be part of

comprehensive logistics service for the supply chain. Characteristics of waste, recyclable materials, its impact on the environment result with numerous regulations of national law as well as international agreements and conventions regulating cooperation with service providers [6].

Due to the diversity of enterprises participating in reverse logistics, wide range of issues to be agreed there are differences in the expected effects of cooperation, as well as the need to ensure continuity and security of cooperation. It is important to properly prepare and conduct negotiations, especially in bilateral relationships. These negotiations are conducted in special conditions, in which the expectations and individual attitudes to cooperation depend on the links with other partners. Negotiating and updating the terms of cooperation in such conditions requires a specific approach [7].

Considering the above statements, the objective of the paper is to present specific features of negotiations between cooperating parties influencing further ability to create and recover the value in reverse logistics. It is also important to indicate the significance of various types of activities for the processes of value creation, as well as value restoration. The significance of individual types of operations affects the roles of the participants carrying out these activities in the negotiation processes.

2 Methodology

The concept of product/service value used in this article refers first of all to generic core designed to fulfil basic customer needs, surrounded by additional attributes or supplementary services [8]. The approach refers also to understanding how the relationship between exchange parties contributes to understanding value. There is also another way to consider value, presented in literature. It relates to trade-off between benefits and tangible monetary sacrifices, as well as intangible costs, that customer make to buy the product [9]. This aspect of the value considerations is not addressed in the article.

As the main approach for the preparation of this article desk research is used. The application of such a concept is supported by the analysis of studies presented in literature in which generalizations and detailed experience are presented, concerning value in reverse logistics and the impact of cooperation with logistics service providers on the processes of value creation and recovery. In order to develop the characteristics of negotiations within reverse logistics cooperation, a number of detailed methodological tools were applied. First of all, the method of analysis and its various types were used, mainly cause-and-effect, structural and comparative analysis. In addition, research tools such as expert method, morphological analysis, scenarios, SWOT analysis, benchmarking, case study, documentation analysis, modelling, synthesis and classification methods were used.

Published studies, taken into consideration can be divided into several groups. The first of these contains basic studies on the genesis and essence of reverse logistics [1,10]. The second group consists of review papers on the essence of reverse logistics activity, its contemporary development trends, as well as structures of cooperation in reverse logistics channel [7,11-16]. The studies included in this group take also into account the assumptions of activity in the field of reverse logistics, principles of shaping the relationship between participants cooperating in reverse logistics, as well as conditions of cooperation with specialized service providers, operating in such areas as: transport, storage, processing of recyclable materials and waste disposal [7,14,15,17]. Considered group of studies includes also the issues of legal regulations regarding the handling of various types of waste and recyclable materials, in particular the conditions for handling hazardous goods [6,13,16]. The third group of studies are those that concern the identification of activities that affect the recovery of values in reverse logistics [15,18]. The last group of studies used in the preparation of this article are those in which the issues of negotiating the terms of cooperation, conditions for the occurrence of conflicts, preparation of contracts, assumptions for limiting conflicts in organizations and between cooperating units were considered. The authors' methodological framework was applied [19], comprising the key dimensions of negotiation's, including the concepts by other authors, e.g. [20-24].

It should be also emphasized, that the preparation of the content is also supported by authors' individual experience in the area of designing reverse logistics management systems, negotiating and preparing the terms of cooperation with service providers specializing in handling used products, products with expired date of use, recyclable materials, as well as waste. Therefore, the characteristics of negotiations carried out in reverse logistics presented in the next part of the article in terms of key dimensions of this type of negotiations is based on the authors' own suggestions as to the interpretation of these dimensions.

3 Results and discussion

3.1 *Reverse logistics as the activity of value recovery*

According to one of the early comprehensive descriptions of reverse logistics such concept is defined as a process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal [1]. The main activities distinguished in the area of reverse logistics include product repair, recycling, refurbishing, upgrade, disassembly of a defective or used product to recover parts for reuse, as well as disposal of products with expired date of use and also disposal of waste [7]. The implementation of these activities requires taking into account transport, selection, storage as well as packaging. More specifically, the characteristics of the tasks related to the flow of goods in reverse logistics include [6,12]:

- collection of goods to be returned to supplier – it concerns identification of incorrectly delivered, redundant, defective goods, as well as the identification of materials, damaged parts and separation of the number of units to be returned, this process may also apply to goods from recipients,
- collection and sorting of expired used, as well as damaged products, waste and recyclable materials, it relates to the qualification of mentioned types of goods for further actions (use of product components in remanufacturing process, recycling, repair of product),
- recovery of parts suitable for remanufacturing by disassembly of products that turned out to be defective and were not sold as a result of quality control after the end of production or due to defects disclosed in the distribution channel,
- recovery of parts from end-of-life products for use in remanufacturing, which requires disassembling of these products, inspection and sorting as well as qualifying suitability for reuse,
- repair of damaged product,
- delivery of waste for disposal,
- recycling of materials for further use in manufacturing process.

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The implementation of the above-mentioned activities becomes possible primarily through the provision of transport. Similarly to forward logistics activities related to transport are emphasized among the main activities that significantly affect the effectiveness of value creation in reverse logistics, [10]. Taking into account four main aspects of economic utility, which influence the value of product for recipient (the usefulness of the form, place, time and possession), it should be indicated, that the aforementioned activities related to securing, preparation

and processing relate to the utility of the product form, as well as possession in the area of reverse logistics. Transport is about the utility of time and place to use this product. It influences also possession of product.

Types of activities presented so far, influence processes of value creation and value restoration in reverse logistics, as it is reflected in Figure 1. The diversified impact of individual types of activities on these processes reflects also the different bargaining power of units specializing in particular tasks in negotiation with the client.

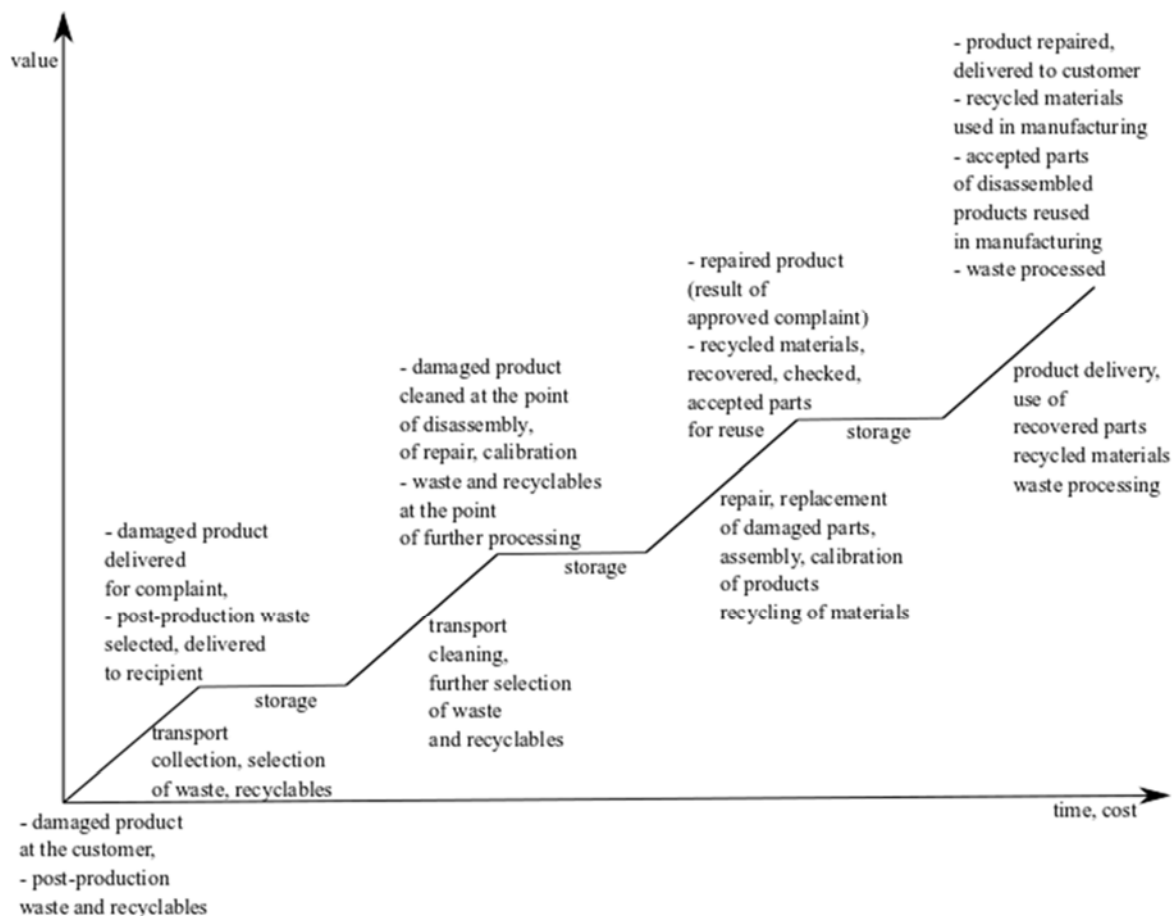


Figure 1 Value creation in reverse logistics (source: own research based on: [11,15,18,25-27])

Considering the information in Figure 1 it should be added, that the places where the increase in value is marked do not reflect the differences in the size of the increase. In addition, presented diagram does not take into account returns of full value goods. In such a case, value creation scheme is simplified. It covers only the return from the point of sale to the supplier, who, after receiving this product, prepares it again for sale and passes it to the distribution chain. The place where a recycled material or a reusable part from disassembled product, accepted for further use is waiting to be used in the manufacturing process means entering the value chain of product manufacturing and delivering it to the customer.

It should be also emphasized, that the value created in reverse logistics is not just about preparing recycled material for reuse in manufacturing process, reusable parts, repairing the product and restoring its functionality to the customer. These are activities related to recovery value associated with the product for the customer. Along with such activities, there are other activities related to the creation of new value, playing also important role. An example is the production of energy in the process of waste disposal by a company, often for own use.

3.2 Types of companies involved in reverse logistics cooperation

Taking into consideration previously mentioned types of activities in the area of reverse logistics, relationships between reverse logistics and the flow of goods in manufacturing process, as well as the ways of specialization of service providers following types of participants can be distinguished:

- product suppliers,
- recipients (using the delivered goods in the further production or distribution process),
- end users of products,
- units disassembling worn, damaged, spoiled products,
- units recycling materials for reuse,
- units participating in waste disposal,
- specialized service providers authorized to collect and transfer waste and recyclable materials to the places of their further use.

In practice, there may be enterprises combining the above-mentioned specializations, in accordance with legal restrictions related to the handling of waste and recyclable materials.

Product suppliers, by establishing cooperation with further manufacturers or sellers of finished products negotiate with their recipients the rules of handing over to the supplier of unused products, products with expired use-by dates, end-of-life products, products being the subject of a complaint, and packaging for re-use. If the supplier of products is also authorized to collect materials for recycling and waste for disposal, the rules for collecting these goods may also be negotiated.

Suppliers may also negotiate with users of finished products the rules for collecting used products or complaints about broken products, treating it, for example, as an additional element of the offer as part of the sale of a new product. Also handing over of the generated waste and materials for recycling (e.g. used packaging, parts replaced during repair) to the supplier may also be the subject of negotiation. Reverse logistics negotiations can also include the rules of transfer of waste to final waste disposal companies. It relates to cooperation with product manufacturers, distributors, units disassembling products as well as companies recycling materials.

Taking into consideration the process of transferring waste and recyclable materials, specialized logistics service providers authorized to collect, segregate and transport waste and recyclable materials may also participate in negotiation with companies mentioned earlier.

Negotiations on the terms of collection of waste and secondary raw materials with such companies can be conducted by producers and distributors of products, companies dealing with disassembly of used and broken

products, companies processing recyclable materials into materials and companies dealing with final waste disposal.

3.3 The dimensions of negotiations within reverse logistics

3.3.1 Process of negotiation

Due to their complexity and volatility, the negotiation processes in general, and those considered here in particular, are not easily structured. They can be disordered, and unpredictable. Some activities are carried out intuitively, spontaneously, and even instinctively. Other ones are formalized by procedures. Quite large amount of data facilitates the implementation of these processes, especially the identification and analysis of the negotiating situation.

The scope of negotiations in reverse logistics can vary greatly depending on the specific characteristics of the goods to be exchanged. Sometimes the negotiations cover the terms of the transaction considering typical, standard elements, and in other cases they concern very specific products and their parameters. In addition, in the negotiation processes under consideration, there are restrictions on the freedom of specialist actions due to numerous legal regulations regarding the way of handling individual types of goods (waste, secondary raw materials, expired products) - security for the duration of transport and storage, requirements of means of transport and storage area, storage process, neutralization of threats to the environment, documentation. Thus, the negotiation processes under consideration may be not only complex, but also very specific.

An important issue is the selection of the right negotiation partners. Whenever possible, they should be undertaken with those entities with whom positive relationships can be forged and maintained. In addition, service providers that have special licenses to handle certain types of goods, such as liquid goods that need to be transported in special tanks, often must be selected. When collecting waste and secondary raw materials from customers, you also need to consider their preferences, limitations in the ability to prepare for the transfer of waste secondary raw materials, out-of-date products to suppliers, etc. As a result, some partners may have greater bargaining power.

There is an increasing need to negotiate with multiple partners at the same time. Undertaking multiparty negotiations is, however, difficult due to the limited possibilities of analysing their context, selecting strategies, arranging meetings, and conducting them. Thus, in reverse logistics, we deal with both bilateral and multilateral negotiations, i.e., with the participation of the aforementioned partners, cooperating in reverse logistics. In addition, negotiations must take into account the conditions resulting from legal provisions, but also the individual conditions of units that specialize in recycling or waste management, etc. As a result, seemingly bilateral negotiations may be conducted under the influence of

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conditions imposed by third parties participating in the processing, etc.

Conducting considered negotiations requires high flexibility of operation and efficient, direct and multi-directional coordination of activities carried out in networks of numerous interactions.

3.3.2 Managing conflicts

It is a competitive dimension of negotiations within reverse logistics as their participants strive to achieve their own goals and obtain the best possible results. They have divergent intentions and different views on the issues under consideration. The contradictions also concern the values, principles, expectations, perceptions, etc., which creates the emotional context of the negotiations, significantly influencing the substantive issues.

On the one hand due to the large amount of data with virtually unlimited availability and a wide exchange of information, the number of potential conflicts between the parties to the considered negotiations may be large, as a result of many different interactions between them. There are very violent and sharp disputes over fundamental, mainly material, issues. There may also be unnecessary data conflicts, very often occurring in practice and sometimes difficult to recognize, but here they do not result from their lack (as is usually the case) but from their excess and mutual lack of understanding, which also causes unnecessary disputes. As a result, the parties to negotiations are then not able to properly identify and assess the causes, effects and the course of such conflicts, as well as the negotiating situation.

The available data may be unreliable, erroneous, selective, incorrectly compiled, etc., or differently interpreted by negotiators. Unnecessary data conflicts can cause other serious misunderstandings, mostly about values and relationships, and even stimulate real conflicts of interest. Therefore, it becomes necessary to provide a reliable and comprehensive explanation of the situation by confronting the possessed information and organizing it based on commonly agreed standards for its presentation and evaluation. This may allow for a relatively quick and cheap solution of the discussed conflicts, which will prevent their escalation.

On the other hand, the increasing speed of action, the multiplicity and virtualization of relations, and sometimes the anonymity of the partners to negotiations mean that possible conflicts are mostly short-lived, unnoticeable, they cannot fully reveal themselves, let alone develop. Moreover, due to possible anonymity of partners or incomplete knowledge about them, it is much more difficult to use competitive negotiation techniques, use the effect of surprise or asymmetry of information, strengthen bargaining power, threaten and promise, bluff, etc., because the parties are "well-informed". It is much easier to explain the nature of short-term conflicts, their causes and effects. They are and must be dealt with on an ongoing basis, when and where they appear, directly through their

website. You can make better use of their positive functions, especially stimulating changes that improve performance.

3.3.3 Reaching agreement

This dimension concerns their intended result, beneficial to all their participants, i.e., meeting their needs. They also have common goals, so they are interested in the results of negotiations, which constitute important values for them (tangible and intangible). The cooperation of the parties is therefore necessary to achieve the desired level of effectiveness. This, in turn, requires concluding a number of contracts (implicit and explicit), specifying the terms of the agreement between them. It is therefore the cooperative dimension of negotiations.

Nowadays, under the so-called revolution 4.0, the possibilities of identifying new, potential negotiating partners are large, provided that there is access to data on their reliability, credibility, etc. The choice of partners, usually made from among many alternatives, is hypothetically easier, because a relatively good recognition of the negotiation environment increases the probability of interacting with relevant partners, establishing and maintaining positive and beneficial relationships based on mutual trust, which reduces the risk for the course and the effects of negotiations. To achieve this, a reliable analysis of the partners' credibility is required.

In addition, in the current reality, sometimes limited, short-term or even virtual contracts are established, which on the one hand frees us from permanent obligations, but on the other hand increases the risk of losses due to the partners failing to meet contractual arrangements or concluding incomplete contracts. It should be noted, however, that with broad, virtually unlimited access to data, signals about disloyal or unreliable partners are easily available in the negotiating environment. In general, negotiators are more inclined to establish and consolidate positive relationships and to use cooperative-oriented negotiating techniques.

It is therefore advisable to rely on proven partners, especially those trusts. Therefore, the scope of cooperation with them should be expanded.

The virtualization of contacts causes that their implementation is usually faster, and it is often necessary to consider many different issues and many different goals, both common and contradictory.

3.3.4 Mutual dependence

There is an interaction of the dimensions of cooperation (collaboration) and competition (rivalry), i.e., the coexistence of contradictory and convergent goals of the participants in the considered negotiations. It expresses the efforts of the parties to achieve a favourable result, conditioned by the necessity to resolve the conflict between them. Neither party can achieve its goals on its own, and at the same time each of them can achieve their goals by others. If the partners saw alternative and more effective

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ways of achieving their goals, they would not negotiate. Thus, such a relationship expresses a close relationship between the two previously discussed dimensions.

In today's business the parties are rarely "doomed to each other", much more often negotiating by choice than by force. On the one hand, a large amount of information available expands the group of potential partners for cooperation, but on the other hand, it makes it difficult to search for and select the right partners and analyse them in the context of negotiations, and competition intensifies, and conflicts may arise. There is much more interaction between the parties to the negotiation. Mutual relations are varied, usually stronger, symmetrical or asymmetrical, although sometimes short-lived or momentary, creating complex networks of connections.

It is easier to build and maintain lasting positive relationships, especially partnerships. You are more likely than usual to establish and maintain positive and beneficial relationships with negotiators based on mutual trust. The aim is to shape and maintain them in order to ensure effective cooperation, beneficial to all, but it is not always possible and/or necessary. Signals about disloyal or unreliable partners are easily available in the negotiating environment. Moreover, generally "well-informed" negotiating parties are more likely to establish and maintain positive relationships, and to use cooperative-oriented negotiation techniques. Cooperation and competition coexist in the form of a cooperation strategy. On the other hand, establishing and developing partnerships is usually time-consuming and generally costly, and sometimes unprofitable or risky. Anonymous functioning in a negotiating environment may turn out to be more beneficial and even safer.

3.3.5 Decision-making process

It is the most important interpretation of negotiations as it expresses direct finding solutions to the negotiated issues by the parties involved. In the preparatory phase, this process is carried out by them independently of each other, i.e. each of them analyses the negotiating situation from the point of view of their goals and interests. On this basis, they determine initial solutions to negotiated problems based on their own criteria for selecting solutions. Then they iteratively make the necessary arrangements of possible alternatives, determining the scope of negotiations, i.e. a set of acceptable solutions to negotiated problems, based on the analysis of the community and divergence of interests. By adopting common selection criteria and rules, they find a solution acceptable to everyone.

In negotiations within reverse logistics, all typical activities within the process of interactive decision-making by negotiators, i.e. identifying problems, collecting and analysing information, generating alternative solutions, selecting criteria for their evaluation, making choices and the necessary implementation works, are facilitated due to both the wide access to data and strong relations of the parties, as well as difficult and complex due to the

specificity of the negotiation process itself and the redundancy of information.

Therefore, the information needs of negotiators as decision makers are, in principle, satisfied to the required degree, so their choices should be accurate, adequate to the problems, made on time, adequately detailed, etc. That substantially increases the quality of decisions. Moreover, it significantly reduces the uncertainty of their performance and the effects of negotiations. In this case, the difficulty may be the excessive amount of data, requiring their careful analysis and selection.

The disadvantages of the decision-making process in the considered negotiations include the need to act quickly, forcing the parties to decide, the presence of an excess of information and the need for careful selection, expanding analyses, and making choices too quick and hasty. As a result, decision-making processes can be more time-consuming, although burdened with lower risk.

Taking this into account, the most significant positive effects of the decision-making process in negotiations within reverse logistics are better and faster decisions, more settlements in real time, data availability for innovation and lower costs.

3.3.6 Communication process

This dimension concerns the mutual exchange of information, "penetrating" all activities of the parties in the negotiation process, from the initial presentation of positions, through: shaping relations, formulating, and exchanging offers, persuading, asking questions and answering, listening, clarifying doubts, etc., to final arrangements and drafting the contract.

On the one hand, as a result of the impact of revolution 4.0, and big data in particular, the exchange of information in the considered negotiations is significantly enriched. The parties to the negotiations have practically unlimited access to all necessary data in real time, although, for obvious reasons, not all information necessary for action is public, presented to everyone on the forum. High availability of information and transparency of communication allow negotiators to properly determine how to better achieve goals. It increases the efficiency of analytical and diagnostic activities. It significantly enriches the tools for conducting negotiations, i.e., increases the number and quality of offers and the accuracy of arguments, improves the effectiveness of questions, facilitates clarification of doubts and the effective selection of negotiation techniques. In addition, virtual negotiations create greater opportunities for the negotiating team to communicate during the negotiations, allowing for establishing a common ground.

On the other hand, negotiators are not favoured by a kind of artificiality of communication during online meetings, a kind of "narrow field of view", and especially by limiting non-verbal communication. It is much more difficult to interpret and analyse the meaning of non-verbal messages of other negotiation participants and their

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emotional behaviour. It is easier to hide some inconvenient facts due to the lack of necessity to disclose some data, which may be a condition for cooperation with negotiation partners. There are fewer opportunities to care for data protection and security, and limited awareness of potential threats in this area.

In general, a wide exchange of information and efficient communication allow to better meet the information needs of the participants to negotiations within reverse logistics. They improve the throughput of omnidirectional communication channels. They increase the usefulness of information in terms of its detailed parameters, i.e., reliability, authenticity, proper form, appropriate detail, etc.

3.3.7 Mutual exchange

It must take place on terms jointly agreed by the parties, through mutual agreements and concessions. It is favoured by the differences in the hierarchy of negotiators' goals, i.e., it seeks to obtain significant resources and values, giving back less important but important for other parties in return. It concerns not only tangible resources, as well as intangible ones, i.e., ideas, ideas, concepts of solutions.

On the one hand, the positive aspect the negotiations processes under consideration is mainly expressed by supporting the determination of the scope and conditions of a possible exchange due to the wide range of interactions and cooperation between the negotiating parties and the appropriate scope of communication between them. It is much easier to obtain and transmit full and reliable information about the needs of the parties and to gather the necessary data on mutual requirements and expectations already in the initial phase of the negotiations, as they are widely available. In other words, it is not difficult to define and confront the preferences of the participants in negotiations, as their expectations are not undisclosed or unclear.

Potential exchange offers are precise and well-thought-out, oriented not only towards material values. There are favourable conditions for the creativity of the parties in the search for opportunities to exchange immeasurable assets. It is easier for negotiators to create wider possibilities of meeting their needs mutually. They rarely show a tendency to formulate non-equivalent exchange proposals only for the purpose of achieving quick and immediate benefits, especially tangible ones. Negotiations based on interests dominate, not simple haggling. There are many options for selecting potential exchange partners and their offers. It is easier to obtain and communicate complete and reliable information about the needs of the parties and to limit focus on immediate needs at the expense of long-term effects.

On the other hand, the significant acceleration and increase in the complexity of the considered negotiation processes may cause them to appear too quick and simpler exchange proposals with a higher "weight", entailing greater risk. Undoubtedly, greater precision is required when formulating exchange offers. In addition, there may

be opportunities to surprise other negotiating participants when they are not prepared to accept certain proposals.

3.3.8 Creating values

The interdependence of the parties and the process of mutual exchange in the negotiations allow the parties to the negotiations to achieve mutual benefits by creating additional value, which would not be possible without negotiation. These common values are a synergistic effect of the cooperation of the parties. Creating them is also possible when one party has something to offer that is not worth much for itself but is of great value to other participants in the negotiation - and vice versa. By exchanging these values, each side loses little, but gains a lot. Within reverse logistics usually we face the process of values recovery, creating a new one. It should be emphasized, that this is another aspect of value creation in cooperation in reverse logistics, next to the previously presented issue of recovering value related to the use of parts from damaged products, use of recyclable materials, waste, etc.

Therefore, negotiations within reverse logistics are characterized by the ease of their parties agreeing on common values that are to be the subject and effect of cooperation. Orientation not only on the immediate effects of negotiations, the strength and durability of relationships, their positive nature, mutual trust of the parties, wide exchange of information about the values themselves and the possibility of achieving them make their co-creation much easier. At most, the prospect of quick and measurable benefits as an effect of the temporary cooperation of the parties may induce them to try to obtain these benefits.

There may, of course, be the danger of unjustified appropriation of resources, and as a result, reliable partners must be relied upon in the search for common values. In addition, cases of such unethical activities are exposed online and widely stigmatized. Differences in the assessment of the values represented by their participants, i.e., different priorities, create the potential for reaching agreement through the exchange of values that are beneficial to them. On an ad hoc basis, these values may be of little importance to the parties to the negotiations but bring them benefits deferred in time. Moreover, potential conflicts of values can and should be resolved by explaining their causes and by convincing each other about the positive impact of different values on the negotiation processes.

4 Conclusions

To sum up, the following features of negotiations within reverse logistics can be indicated:

- substantial acceleration of the conduct of these processes, especially pre-negotiation analysis (specifying, for example, bargaining power of parties resulting from the importance of each party in the process of creating or restoring value in reverse logistic, obtaining recommendations),

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- significant increase of the scope of such analysis in a wider negotiating environment (e.g. taking into account the influence of other entities cooperating with negotiating parties),
- searching for trusted negotiation partners, shaping and maintaining positive relationships with them,
- adopting a broader perspective when looking for possible alternative solutions (e.g. considering other potential service providers of the same type, avoiding excessive dependence on the entity with which one is negotiating),
- increased flexibility of performance, especially when searching for options for solutions,
- seeking for new strategies and negotiation techniques aimed at finding a balance between cooperation and competition,
- enriching the tools of multiparty negotiation, more and more dominant in contemporary socio-economic life,
- full acceptance of the multicultural nature of the negotiating environment and its creative use,
- particular attention is related to compliance with limitations resulting from law on environmental protection, treatment of special types of goods, dangerous goods waste and recyclable materials as well as with requirements of permits for transport, storage, securing, etc. resulting from these regulations,
- paying much more attention to information security,
- using modern systems of supporting negotiations via the Internet.

These are not all the suggestions that are useful in negotiating with service providers in the area of reverse logistics. Those presented are treated as most important.

The main advantages of the suggested concept of negotiations are as follows:

- it is conducive to effective cooperation between companies,
- moreover supports the management of relations among them,
- what is more, it influences the effective shaping and maintenance of partnership relations between them,
- stimulates the search for effective solutions to problems arising in cooperation,
- facilitates the resolution of potential and real conflicts within cooperation,
- helps to reach compromises and consensuses while resolving these conflicts,
- supports the search for creative solutions to improve cooperation,
- leads to the conclusion of effective contracts between partners,
- in the end, it increases the efficiency of cooperating parties, as well as entire supply chain's performance.

On the other hand, the following disadvantages of the suggested concept may be pointed out:

- its use can sometimes be too laborious,
- it may leave aside the scope of considerations of secondary but important conflict goals for individual parties to the negotiations,
- sometimes it leads to the conclusion of the so-called sick compromises that do not satisfy any of the participants,
- companies having strong bargaining power may dominate over other co-operators.

The suggested concept of the description of negotiations within reverse logistics cooperation presented in the paper is a preliminary approach to the issues under consideration, since they are relatively new, not fully recognized in theory and research, as well as in economic practice. Therefore, the authors will strive to enrich and broaden his concept, mainly by searching for more precise characteristics of the considered features of the negotiations under consideration. It is also planned to conduct comparative empirical research in order to verify the usefulness of this concept.

In addition, it is planned to expand the context of considerations, i.e. to create a broader concept of the conditions of negotiations within reverse logistics cooperation in the current economic reality by proposing the principles of their conduct, and thus creating a specific normative model of such negotiations. The second, promising direction of research will be considering the more general issue of managing relationships with partners, and not only the negotiations with them.

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Design and control order picking route of a retailer warehouse using simulation to increase labour productivity

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Abstract: The aim of this study is to find out the optimal path for the manual picking process used by warehouse operators to enhance the productivity of the manual picking system in the retail warehouse in Jordan using simulation Software. WMS Software was used to determine the different picking methods and the distance travelled in each path of the order-picking process to discover the optimal layout design for the warehouse. Several time studies were conducted using the stopwatch to determine the average picking time for each operator using those paths that were suggested by the simulation program to choose the same arrangement. Then, the average throughput was calculated for each operator for each routing method. The results showed that there is a strong correlation and relationship between the routing method and operator productivity. Further, it is found that productivity is higher by 29% when the operator chooses the optimal path shown by the simulation program, and this improvement in order picking will lead to a high level of service satisfaction and a lower level of operational cost for storage. Improving picking methods and optimizing picking paths can increase the total number of orders an operator can fulfil in a single working day, resulting in increased operator utilization.

1 Introduction

Warehouses are the link between production points (such as factories and the like) and various sources of consumption in the supply chain (SC), so the work of warehouses is considered important and necessary in different SCs [1]. In this study, we use one way to reduce the handling time by finding the optimal routing design of the warehouse. Most retail warehouses have difficulty defining the accurate workforce, because the workload is highly variable and volatile, particularly the outbound businesses that have strict commitments. The storage process is directly related to other logistical operations such as transportation, care, picking, handling, loading, unloading, packaging, processing and repair and maintenance operations for goods and products between different production points and consumption points in different markets and countries [2]. There are several different operations and activities that take place inside warehouses, such as receiving orders, locating storage, replenishing the shortage of products, preparing and processing different orders, accumulating and sorting goods, packaging, and distribution, sending orders and shipping them within their specified time.

The order-picking process is a retrieving logistical activity of different products from particular storage zones according to customer orders. Generally, one of the logistical activities inside warehouses that consumes a long time is the processes of selecting and picking different orders, as it contributes significantly to raising the total storage costs. [3] indicated in their study that 70% of the time it takes to pick the order, while it includes 55% of the total storage costs. The order-picking logistical task could be multi-dimensional (i.e. one, two, and up to three). Order picking productivity can be enhanced by minimizing the

time of handling. The factor of picking time can be divided into the time required to reach the product storage location (walking and access time). In addition to the time of other remaining logistical activities such as the time of product selection and picking the products (obtaining a pick list and an empty pick holder) through manual selection processes inside warehouses, and often it is considered time access to the product is the largest factor in the total time at the time of picking [4]. To decrease the tour time to pick up the order, various methods can be used through more efficient control mechanisms. Zoning is one of the method that used to minimize the travel times, that is an order picker picks just that part of an order, which is in his or her assigned zone. Other method is the storage task rules that can decrease tour times by allocating goods to the correct storage positions. For instance, repeatedly demanded goods can be stored where they are readily to be accessed. Another approach is to accumulating/assorting as a means of minimizing tour times. Accumulating/assorting is interested in collecting different orders in a one-order-picking track (i.e. partially). The last method is to define good routes for order picking. The process of sequencing and finding the products required retrieving them from their storage places and positions must take into account the distance travelled to reach them. It is desirable that it be known and as short as possible, and this in itself is a problem in determining the paths and methods of selecting and picking orders, hence this study, which will present performance comparisons between optimum routing and inference on repositories [5].

This study was conducted in aim of performing five different manual routing maps created by the simulator for different methods including: S- shape combined, aisle-by-aisle, large gap in addition to a self-experimental rout done

by a picker by walking through the warehouse to pick items as well as an optimal one in the retail warehouses in Jordan. The performance of all those routes is compared to identify the best and optimal order-picking route for the same order with the highest picker's productivity in the warehouse; that generates the shortest order picking routes. The S-shape routing policy or the traversal strategy that each sub aisle including at least one requested item leads to a path that is traversed totally. These path aisles are travelled in an S-shape form [6]. It is the simplest strategies for routeing pickers he or she gets in an aisle from one end and leaves from the other end, starting at the left side of the warehouse. In the picker returns to the front end of the aisle after picking the last item. Routing strategy is used when the further time to modify lanes/aisle is terse and the quantity of picks per aisle is few. The idea was presented as an aisle-by-aisle route by [7] which refers to the route that the order picker visiting each pick aisle only once. In this strategy, the tour will start from the left side of the corridor/aisle that exist in the warehouse containing the items, the items in that main corridor/aisle are selected and a cross corridor/aisle is chosen to move forward to the next main corridor/aisle. Therefore, this route specifies the intersecting lanes/cross-aisles that must be used and walked in them from one corridor/aisle to another in a sequential manner so as to reduce the distances traveled to select the request. Minor changes have been made to this adopted path since these paths start and end at the warehouse and that because this rout compatible with the other routing strategies [8]. The combine or hybrid routing method combines and merges the best attributes of the return and cross-cut methods. The composite strategy minimizes the journey distance between the extreme picks in two closest aisles [9]. This route will be started and ended by a picker at the warehouse. Then picker moves through the leftmost pick aisle that consists of goods across the block outmost from the warehouse that has goods. Consecutively, the sub-aisles of the furthest bay/zone are visited from the left-hand side to the right-hand side. After that, the picker gets into the next block/bay; the one block/bay that is nearest to the warehouse. Then picking the items in this bay/block. Then again until all bays/blocks with items have been visited. The sub-aisles are either totally traversed or the order picker enters and/or leaves the sub-aisles from the same flank [10]. Optimal routing method is calculated the shortest order picking routes in warehouses, regardless the design or storage places/positions of the items. The best (short)/optimal routes seem like a blend of S-Shape and the largest gap. The majority of order picking processes use heuristic routing methods. This strategy is commonly used in practice since it simple to know more and produce routes that are quite consistent in nature [11].

Therefore, this study sheds light on the analysis of the process of picking orders in retail warehouses in Jordan to reach the solutions and recommendations that are necessary to solve the problems related to this important

process, where the rest of the parts of this study are included the following sections. Section 2 is a background literature review that is highlighting warehousing and order-picking operations and optimization, in addition to the warehouse's internal layout and routing tracks and extensions of some current routing methods. Section 3 contains the purpose and the study questions. In Section 4, the simulation model is described to compare the performance of all routing methods. Section 5 illustrates the results and discussion. The conclusions of this study are available on section 5. Finally, section 6 includes limitations of the study and future works.

2 Literature review

2.1 Warehousing and order picking systems optimization

Warehouses are considered a safe place to receive goods and products in large quantities. Warehouses provide the necessary environment to maintain them in a safe and secure manner and for varying periods of time, then work on preparing and rearranging them according to customers' requests to send them in smaller quantities and in different places. This is knowing that warehouse operations contain inbound logistical processes (i.e. receiving, and storing goods, etc.) and outbound logistical operations (.e. order picking, packing, distribution, etc.). While warehouses frequently control the smooth flow of products in a good manner due to restricted linkages with their providers/suppliers, many prior studies concentrated on either outbound or inventory logistical processes [12]. Usually, most of their customers work in a timely manner (i.e., just in time) and have an urgent need to receive their orders and deliver them within a period short time. While inbound warehouse operations minimum time tension is exercised as arriving products are stocked as safe stock without the use of few unit load handling [13], except for cross-docking products. In addition, warehouses have the ability to adjust their workforce within the warehouse to speed up the preparation of various orders for their customers due to fluctuations in demand, which facilitates accurate forecasting of the volume of short-term work and effective labour management necessary for chain operations as a whole. In addition to identifying and choosing appropriate locations for storing goods in order to speed up the various picking operations and optimizing routes and time [14].

The picking of orders is considered one of the most important operations within warehouses, which require time and cost in preparing customer orders, for this reason it requires the provision of a large human factor in order to reduce the time required for the picking process as much as possible and to the minimum [15]. Therefore, the process of picking orders is considered one of the processes that require more labour-intensive operations inside warehouses, especially those warehouses that still use manual systems in the picking order process, which

increases the operational cost of the entire supply chain. As for warehouses that use modern and automated systems. They require labour less, faster, and less time, which increases the level of service in a satisfactory manner. Knowing that most of the previous studies indicated in their results that the picking order process is estimated at more than 50% of the total operating expenses of warehouses. As a result of that competitive models for cost reduction help the professionals of warehousing to take into account the order-picking logistical activity, which is considered the highest factor portion to improving the productivity [16]. Most of the previous studies indicated and focused on the importance of picking orders and including them in one of the four operating strategies in order to improve the performance of the system through proper and effective planning of material flow, picking orders in a sequential manner, effective routing, as well as choosing suitable and more effective storage places. In addition, the policy of the process of picking orders includes designating the appropriate elements for handling the materials, and determining the locations of the orders, and the best paths for the rounds of picking through a number of effective functions. Additionally, including them in the system such as collecting, sorting, batching, classifying, and dividing areas/zones in a way that suits the nature of the stored materials. Where, paths are identified and directed to pick different orders in several ways, ranging from simple heuristics to the optimal path and procedures. It is necessary to estimate and specify the SKUs for each product in its storage locations. In general, the most widely used and common warehousing operations are random warehousing, which depends on the basis of category warehousing, so that goods are sorted on the basis of ABC analysis across different warehousing categories. Therefore, proper and organized planning processes based on a scientific and thoughtful basis play an important role in choosing the efficiency that involves guidance, the selection site, and the identification of cross paths and paths [17]. Increasing the service level of productivity with respecting resource constraints is the most popular aim of order-picking operations. The ultimate important connection between the order-picking operation and the level of service required is that the acceleration the picking is done will become better. Travel of journeys is performed around 50% of the time required for the order-picker process in an ideal picker-to-parts warehouse. Therefore, it is a most committed issue for improvement. [18] presented an optimized journey time or journey distance in short time and way in the warehouse. Thus, the manual picking order processes that the person can concentrate on the typical internal warehouse layout design, stock activity approaches, routing approaches, demand batching, order sorting and allocation, and zoning as shown in (Figure 1). [19] presented that six policies that were mentioned previously, if they are improved, ensure that warehouse work remains within the tactical and operational levels alike, and this procedure is necessary and important for

warehouses whose decisions are based on a strategic basis and are not easy and expensive for alert purposes. The warehouse's internal layout design regards the defining the number of blocks, in addition to the aisles' length and range in each block. Therefore, the primary goal is to reach the best layout, and approach for warehouses. In relation to certain functions, taking into account the main requirements, restrictions, regulations, and security and protection instructions for both personnel and products. With a great focus on the important, sensitive, and most common function, which is determining and calculating the distance and time of arrival to the goods to be reached quickly and in the least time [20]. It is possible to follow the scenario of zoning within the warehouses, where the order-picking zone can be split into various other areas/zones, each area/zone for which a certain operator is allocated so that he chooses the part of the order within the area/zone allocated to him/her. Therefore, one of the main advantages of zoning is that each picker is limited to a specific area only, which works to reduce traffic congestion and allows the picker to identify the main contents of the goods within his/her designated area/zone. However, this scenario is represented by a major disadvantage, which is the division of orders, which often works to merge orders with each other before the process of transferring and shipping them directly to the customer. As for the order batches, it works to set specific groups of orders into a certain number of sub-orders, after which every group can be picked during one round of picking. Two factors for this batching process are the nearness of the picking sites and the time. [21] defined the accumulation/sorting (A/S) process as the collecting meet the items per customer order by applying the batching and/or zoning with some further efforts. The aim of the work presented in this case study was to find out the best approach for improving the overall productivity of the picking orders process in the warehouses (select the best routing method). To achieve this aim, a method was enhanced to estimate the productivity of the manual order picking, taken into consideration various options, in a total of five options (including 5 routing methods in addition to self-experimental case), respectively after the implementation of various routing methods. By applying and created, a simulation model in this study, the picking time was considered for measuring of the performance. A variety of alternative routing methods was tested.

2.2 Labour productivity

In retail distribution warehouse the customer demand is usually customer orders are characterized by short-term fluctuations. In a number of recent studies that were applied to warehouses, it indicated in its results that warehouses in general resort to hiring permanent employees and temporary workers in order to keep pace with the change in requests and adapt to the fluctuations that may occur at workload [22]. Some warehouses deliberately work to their full capacity and staff from

permanent employment in only one case if they cannot depend on tentative employment obtainable at the appropriate one. This study presents that the enhancement of the labour productivity by using the optimal routing method could help the decision makers to organize and manage the number of workers in warehouses, which is a vital and important issue, it is necessary to deal with and keep up with fluctuations in daily customer request.

2.3 Warehouse layout design and routing methods

In this study the warehouse layout 's sketch has parallel of pick aisles and has no unused space as shown in (Figure 2). The warehouse layout consists of two blocks, in which every block has a number of sub aisles. Whereas inside each block a sub aisle is part of a pick aisle. The aisle' can be used when a statement holds for both aisles including the pick and sub-aisles. Cross aisle exists at the back and front of the warehouse and in the mid site of every pair of blocks. In spite that cross, aisles do not have storage locations and do not contain items, through which it is possible to work on the use of aisles. Each block contains a corridor that connects the front façade with the rear of the storage area, as the rear façade of one of the rear blocks serves as the front aisle for the block that is located in the front façade excluding the first block. Therefore, the number of intersecting aisles inside the warehouse is the number of blocks adding one, due to the presence of one cross aisle in the front and another in the back, in addition to the presence of other passage between every two blocks adjacent to each other [23]. The operators of the order picking are supposed to be able to pass and cut aisles in both directions and also be able to alter direction inside the aisles as well.

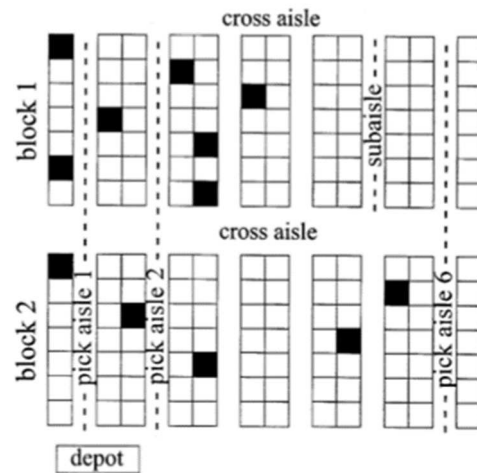


Figure 2 The warehouse layout with multiple cross aisles

[24] show that the aisles are narrow enough to allow picking from both sides of the aisle without changing position. Each order consists of a number of items that are usually spread out over a number of subaisles. Where the warehouse is located at the beginning of the first aisle of the first interface, and also note that the location of the warehouse can have a major role on the mean journey time. Routing policy is a policy to determine the route inside the warehouse. The term route refers to the path that go over an order of all of the item. Routing strategy linked with ordering a pick list in an organized order that will reduce the travel distance of the order picking [25] showed that the aim of routing techniques is to put the products in sequence on the pick schedule to produce a proper route over the warehouse. Practically, the problems of the order pickers routing in a warehouse is almost resolved using heuristics [26] mentioned in their study, that number of empirical and practical methods were distinguished for routing the order pickers in the depots. However, they were carry out the single-block storage process, with presenting a number of methods such as traversal in the form of the letter S, the midpoint, return, the large gap method, and the aggregate method (compound). This study describes below different types of routing: S-shape and largest gap, both of these two route are a well-known route for basic layout. Moreover, aisle by-aisle route, which is the routing method of [27]. The fourth one is the combined route; it is a combined strategy (hybrid) that accumulating parts from S-shape and largest gap. In addition, the optimal route for finding the route of the shortest travel distance.

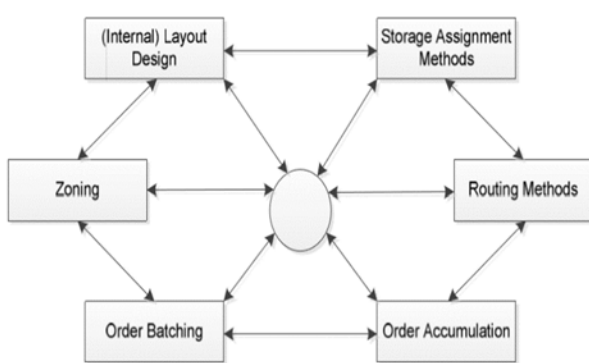


Figure1 Improving low-level, non-automated order-picking tasks [14]

2.3.1 S-shape

The S-shape routing technique is also called the traversal strategy that every aisle containing at least one requested item leads to a path is traversed totally. It is the simplest strategies for routing pickers this route is where an order picker gets in from the edge of the aisle, while departing from the end of the other edge, starting from the

left side of the depot. Aisles and sub-aisles are bypassed and skipped, when there is no process to pick anything up any order. Therefore, in this route, the main aisles are passed in the form of the letter S. The picker returns to the front end of the aisle after picking the last item. This route is used usually, since it is very easy and simple to apply it. However, it outperformed by more complex heuristics. [28] in their study, they mentioned that this strategy works to enhance the time and distance of the round, because it can lead to the picker making rounds in other sub-regions/aisles in the cluster regions from left to right. Therefore, the picker has to traverse a large portion of the forward choppy lane (cross aisle) before he can return to the beginning of the warehouse. The function of the time-complication of this route is distinct from the number of pick positions and enhances linearly with the number of picking aisles. Sub-aisle has in basic not less than one pick location traversed over the whole length. In addition, as [29] showed, where the pick-up process performed by the picker starts from the front of the warehouse and takes place for proceeding ahead, then starting from the main aisles closest to the front façade of the warehouse, which contains at least one item and more. The process will be as in the following steps: (1) the main aisle of the warehouse is crossed to include the farthest block, which contains one item or more. (2) In the current block that contains only one element or more, the picker will immediately go to the left aisle that contains more elements, or it will go to the right aisle, which also contains other elements, so that it will be the closest one in this case. (3) After that, the picker will pass from one aisle to another aisle, so that it traverses the aisle containing the elements completely, then the picker will return to the beginning of the block (4). In case the block that has no elements, the aisle of that block is traversed, as this process will be repeated for all blocks until reach the block that is closest to the warehouse is reached (5). Lastly, the order picker goes back to the depot. See (Figure 3).

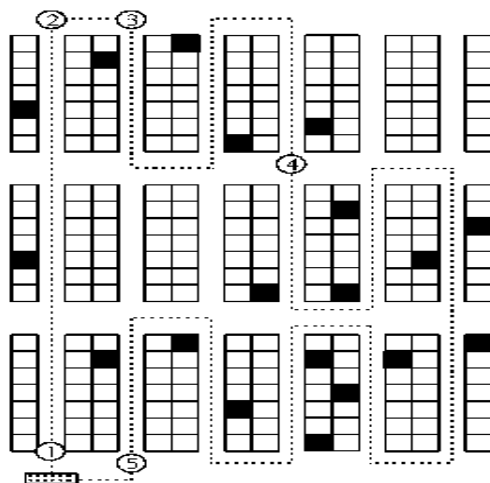


Figure 3 S-shaped route-routing order pickers in a warehouse

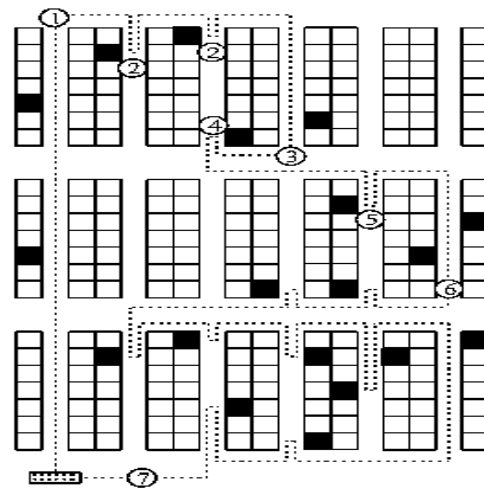


Figure 4 Largest gap heuristic-routing order pickers in a warehouse

2.3.2 Largest gap route

This strategy occurs when the order picker enters the aisle further into the gap of that aisle as well as all of the aisle's sub-aisles. This gap works to separate any two picks that are closely close to each other, meaning the first pick and the first pass picker, or the amidst of the last pick and the back aisle. Where this route is divided in the picking areas into two main groups through the sub-aisle, where one group is dealt with and entered in these locations through the use of the crossed back aisle, while the other groups are entered through the front cross aisle. In the block that one of the two groups is empty or even both, it is not important to enter the sub-aisle from this side. The largest gap inside an aisle is the order picker does not traverse the portion in that. When there are a largest gap between two picks which adjacent to each other, the picker chooses the route back by using both ends of the aisle. Moreover, a return route from the front or back aisle is used. The back aisle can just be accessed through the first or last aisle. This routing strategy used in the case that the extra time is short to change aisles, the amount of shots each aisle is also small. [30] showed that this route usually outperforms the midpoint approach and the S-shape when the pick density is less than about four picks in each aisle. While, from an application viewpoint, the midpoint approach is easier and more direct. As shown in (Figure 4) in which the largest gap route is used to pick items, like the S-shape route, the picker advances to the front of the nearest aisle in the warehouse that contains one or more items. Therefore, the aisle that contains the element is almost from the right or left side, since this aisle is completely traversed. Then, each aisle is entered at the posterior end of the depot until the "largest gap" and left from the same side in which it was inserted. After that, progress is made through the last aisle forward, and then the aisles that are located at the front end of the warehouse are entered into the "largest gap", which leads to the

existence of another gap between each two adjacent picking sites, either within the sub-aisle or between a cross aisle and the nearest picking site. If all items to be prepared have been picked up, the picker returns to the warehouse.

2.3.3 Aisle-by-aisle rout

[31] presented this rout in which order picking routes visits each main pick aisle will just once. Where the first round of pickers in the warehouse begins by entering first from the far left side of the aisle that contains the items, and then the process of picking and selecting all the required items in this main aisle takes place, after that to move forward to the next main aisle, the cross aisle is chosen. Where this process will be repeated until all the required items in the main aisle are picked up, in addition to that, the work of the pickers continues in the next main aisle. Where the paths of the cross aisles that must be toured are determined and used to move from one lane to another in a way that reduces the distances travelled for the picking process. Some minor modifications are made in this tour because these tours start and end at the warehouse, and because the aisle is sometimes compatible with other routing strategies. See (Figure 5).

2.3.4 Combined (hybrid) rout

[32] presented the composite routing method. This rout combines and merges the best attributes of the back and transversal methods. The composite strategy decreases the journey distance between the outermost picks in both adjacent aisles. [33] state that the aisles with picks in this rout are either entirely traversed or entered and left at the same end. In addition, it was indicated in their study that one of its main advantages is that it is distinguished and superior to other experimental methods/heuristics in numerous cases.

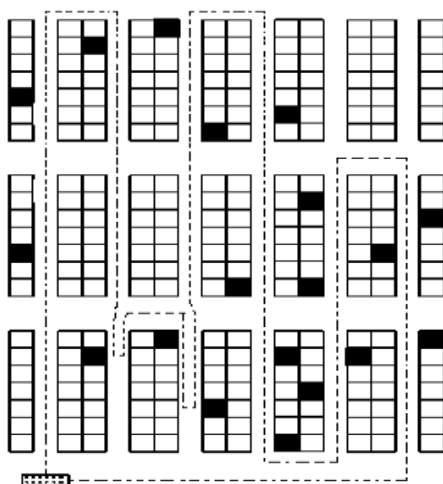


Figure 5 Aisle-by-aisle routing order pickers in the depot

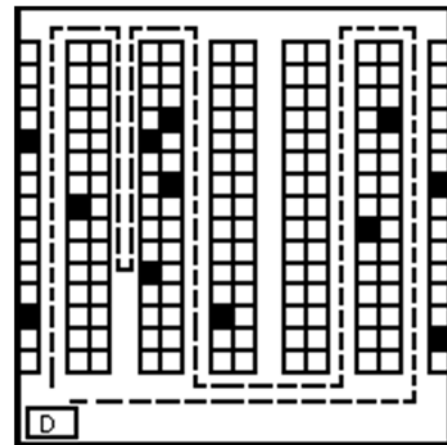


Figure 6 Combined route-routing strategies



Figure 7 Research model of this

Furthermore, [34] in their study, a comparative study was conducted of 80 cases in different warehouses for six methods of routing to report the combined heuristic, which was referred to in the results of the study on 74 cases out of 80 that they studied and analysed. Combined's drawbacks that being dynamic, the order picker is not allowed to recognize the routing heuristics. Furthermore, [35] developed a strategy in each case in which all the elements of one aisle are picked, an inquiry arises about going to the back end of the aisle or returning to the front end of the aisle. By making comparison of these, both choices with each other to know which substantial will produce the shortest route. Therefore, there are always two routes that are possible to follow. See (Figure 6).

From a practical point of view, there was a need to highlight and use a routing strategy that generates clear and simple pathways to understand its structure. There are different patterns of clear routes, which work to reduce the time required to pick the product by the picker in finding and specifying storage locations for different materials, as well as working to reduce the risks of errors that may occur during the selection/picking process. Therefore, the mixed/hybrid routing method may result in such kind of use of these routes. Order picking routes visits each sub aisle that contains items just once. This rout will be started and ended by picker at the warehouse. After that, the picker goes along out of the pick aisle, usually from the left side, which consists of several items, towards the block farthest from the side of the warehouse, which contains the items needed to be picked. Consecutively, the process of visiting the next aisles branching from the main aisle (sub-aisle) to the farthest block from the left to the right, after that, the

picker enters the logical block of the next block. Which is considered the one block and is the closest to the warehouse, and then the picker selects the elements to be selected/picked in this block. Then this process is repeated until all the blocks that contain the elements to be accessed are visited, picked and prepared, where the sub-aisles are completely crossed or the order picker enters and leaves the sub-aisle from the same side [36].

2.3.3 Optimal routing method

An optimal routing developed by [37] to route warehouse operators to walk in a rectangular manner in the warehouse without cross aisles. Regardless the design or storage location of the items, this strategy is calculated the shortest order picking routes in warehouses. Optimal routes seem like a mixture of S-Shape and Largest Gap. The majority of order picking processes use heuristic routing methods. This strategy is commonly used in practice since it simple to know, produce and understand the consistent pathways/routes in nature.

3 Purpose of the study and research question

This study aims to find out the correlation between the productivity of the operator with the different routing methods used in the picking process. Moreover, it answers the question of how the rout layout of the manual picking process effect operator productivity in the warehouse. The research model of the study presented following scheme as illustrated in (Figure 7).

4 Research methodology

4.1 Research design

This study mainly follows a simulator software. The first research question is about the optimal layout design of the warehouse routing, and its role in improving the productivity of the manual order picking system. While, the second one is about its benefits in reducing the overall cost in warehouse sector which aimed to describe strategies applied by decision makers to make recommendations for the company through knowing the optimal routes. In this study, various sources of data have been used, including: EHS website, videos, company documents, textbooks, scientific journal articles, internet sources, newspaper articles, as well as documents.

4.2 Methodology

The warehouse studied in this research is a low-level picker to stock manual order picking system. The warehouse layout structure composed of 2 blocks as shown in (Figure 8) each block consists of 6 wide aisles and each aisle have of 11 picking locations, the aisles are open from both side such that allow the operator to move within the aisle in both directions. The depot is located at the bottom left corner of the first aisle, order-picking start from the depot where the operator fined the order list and the cart.

For this case study, an interactive warehouse simulator, time study and excel was done.

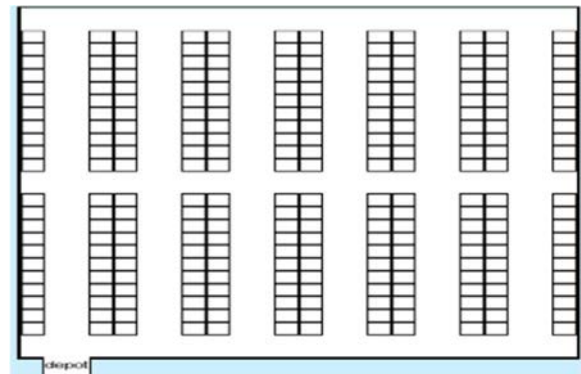


Figure 8 Warehouse layout and depot location/top view (Developed by authors)

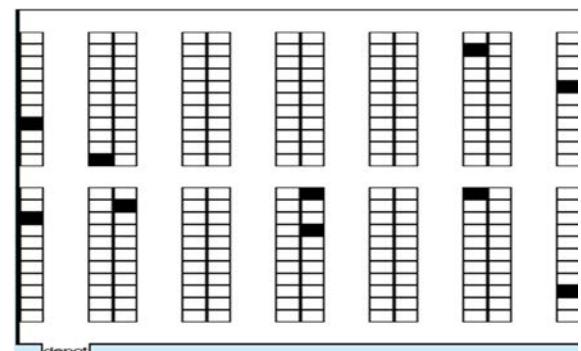


Figure 9 Order distribution-top view of storage area storage area (Developed by authors)

4.3 The interactive warehouse

The simulator was used to determine order picking routes map and the average travelled distance in each rout for the same order distribution, a top view of the warehouse created by the simulator after defending the parameters (number of blocks, number of aisles, number of locations per aisle, depot location, aisle length, crossover length). Each square depicts a storage location. Walking is possible in the aisles between the black squares. The simulator creates a map for five different routing including the optimal one using different methods, which are: (1) S-shape; (2) Combined; (3) Aisle by aisle; (4) Largest gap; (5) Optimal; and (6) Self-experimental. One of the operators was asked to generate his own route (self-experimental), without using any of the routing methods, using the simulator. The simulator calculated the total travelled distance in meter for each route.

4.4 Time study analysis

This study was made to determine the average picking time that the operator needs to complete each route, a stopwatch was used. Picking time T_p is calculated using equation (1) as shown below [38]:

$$T_p = t_1 + t_2 + t_3 + t_4 \quad (1)$$

Where:

t_1 -Average travelling time [s]; t_2 -Average extracting and searching time [s]:

$t_2 = x_1 \cdot x_2 \cdot t_i$ (x_1 - Average number of locations per Order [pieces], x_2 - Average number of positions Per location [pieces], t_3 -Information Processing Time [s]: $t_3 = (10 - 15 \text{ s}) \cdot x_1$; t_i - Time needed for picking, On one position (3-6) [s]).

Five operators did the experiment and they were followed in order to define the total picking time they need to complete each rout. The operator starts from the depot with the map of each rout and he asked to pike the given order using the given route map. For each route, an average picking time was taken. Since the operator work 7 hours/day the productivity of the operator (how many orders the operator can accomplish in each working day)

was calculated for each route to define the effect of routing method on labour productivity.

5 Results and discussion

In this section, the experiment result will be presented to help in understanding the used methodology.

5.1 Interactive warehouse simulation

In this part the simulator generates a random order as shown in (Figure 9), then a map for each routing methods created by the simulator as shown in (Figure 10). The simulator calculated total travelled distance for each route A time study was performed to determine the speed for the five operators using stopwatch after that the 5 operators were asked to pike the order using the given route and the picking time was measured using Equation 1, the result for each route each route shown in following Tables.

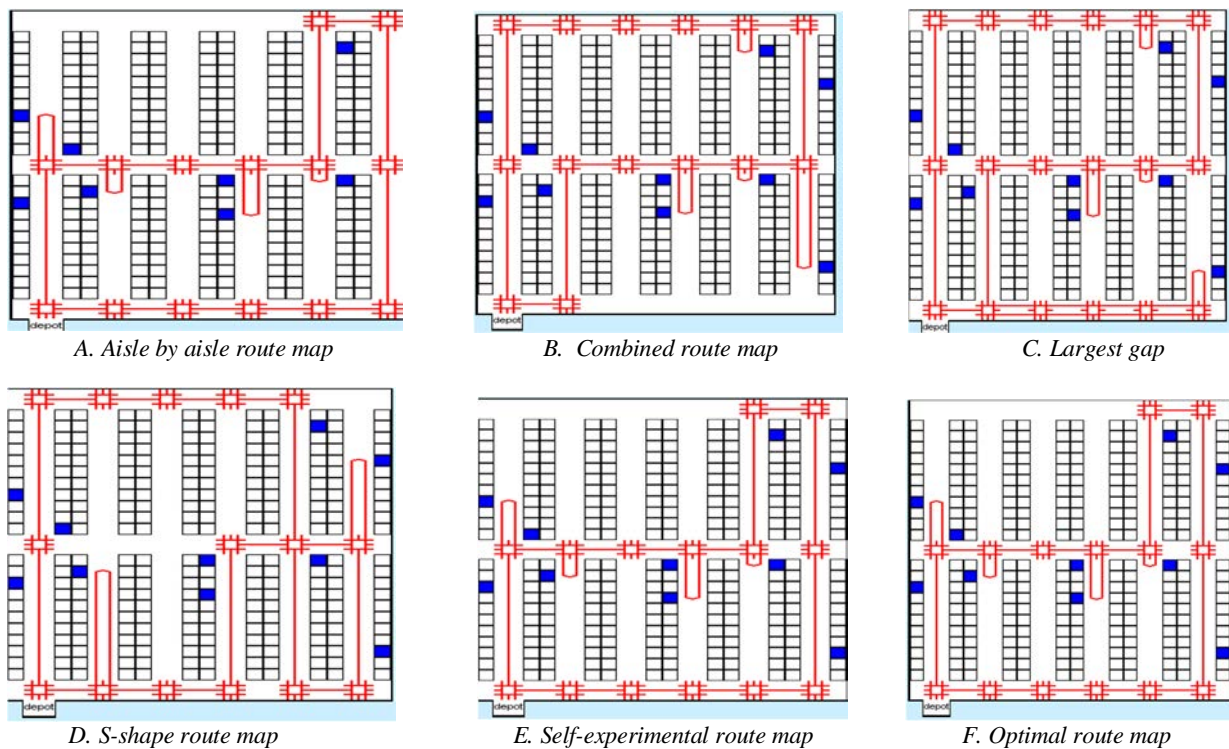


Figure 10 Routes Map-Top View of Storage Area

Table 1 S-shape route total picking time

S-Shape Route		320.09 Meter						
Operator	Speed (m/s)	T1 (sec)	Time Needed for Picking on One Position	T2 (sec)	Processing Time Per Location	T3(s)	T4 (s)	Picking Time(s)
1	0.83	385.65	5.00	50	12.5	125	230	790.65
2	1.23	260.24	3.00	30	10	100	200	590.24
3	0.87	367.92	5.00	50	12	120	250	787.92
4	0.76	421.17	6.00	60	15	150	280	911.17
5	0.9	355.66	4.00	40	11	110	200	705.66
Average		358.13						757.13

Design and control order picking route of a retailer warehouse using simulation to increase labour productivity

Moh'd Anwer AL-Shboul

Table 2 Combined route total picking time

Combined		244.45 Meter						
Operator	Speed (m/s)	T1 (sec)	Time Needed For Picking On One Position	T2 (sec)	Processing Time Per Location	T3 (sec)	T4 (sec)	Picking Time(s)
1	0.83	294.52	5.00	50	12.5	125	230	699.52
2	1.23	198.74	3.00	30	10	100	200	528.74
3	0.87	280.98	5.00	50	12	120	250	700.98
4	0.76	321.64	6.00	60	15	150	280	811.64
5	0.9	271.61	4.00	40	11	110	200	621.61
Average		273.50						672.50

Table 3 Largest gap routing total picking time

Largest Gap		237.55 Meter						
Operator	Speed (m/s)	T1 (sec)	Time Needed For Picking On One Position	T2 (sec)	Processing Time Per Location	T3 (sec)	T4 (sec)	Picking Time(s)
1	0.83	286.20	5.00	50	12.5	125	230	691.20
2	1.23	193.13	3.00	30	10	100	200	523.13
3	0.87	273.05	5.00	50	12	120	250	693.05
4	0.76	312.57	6.00	60	15	150	280	802.57
5	0.9	263.94	4.00	40	11	110	200	613.94
Average		265.78						664.78

Table 4 Aisle-by-aisle route total picking time

Aisle By Aisle		215.36 Meter						
Operator	Speed (m/s)	T1 (sec)	Time Needed For Picking On One Position	T2 (sec)	Processing Time Per Location	T3 (sec)	T4 (sec)	Picking Time(s)
1	0.83	259.47	5.00	50	12.5	125	230	664.47
2	1.23	175.09	3.00	30	10	100	200	505.09
3	0.87	247.54	5.00	50	12	120	250	667.54
4	0.76	283.37	6.00	60	15	150	280	773.37
5	0.9	239.29	4.00	40	11	110	200	589.29
Average		240.95						639.95

Table 5 Self-experimental route total picking time

Self-Experimental		380 Meter						
Operator	Speed (m/s)	T1 (sec)	Time Needed For Picking On One Position	T2 (sec)	Processing Time Per Location	T3 (sec)	T4 (sec)	Picking Time(s)
1	0.83	457.83	5.00	50	12.5	125	230	862.83
2	1.23	308.94	3.00	30	10	100	200	638.94
3	0.87	436.78	5.00	50	12	120	250	856.78
4	0.76	500.00	6.00	60	15	150	280	990.00
5	0.9	422.22	4.00	40	11	110	200	772.22
Average		425.16						824.16

Table 6 Optimal route total picking time

Optimal		215.36 Meter						
Operator	Speed (m/s)	T1 (sec)	Time Needed For Picking On One Position	T2 (sec)	Processing Time Per Location	T3 (sec)	T4 (sec)	Picking Time(s)
1	0.83	259.47	5.00	50	12.5	125	230	664.47
2	1.23	175.09	3.00	30	10	100	200	505.09
3	0.87	247.54	5.00	50	12	120	250	667.54
4	0.76	283.37	6.00	60	15	150	280	773.37
5	0.9	239.29	4.00	40	11	110	200	589.29
Average		240.95						639.95

The average Picking time for each route was calculated as shown in the above Tables 1, 2, 3, 4 and 5, then the productivity, how many order that the operator can perform in one working day, was calculated as shown in Table 6 for the operator when he use each route using equation 2:

Total working hours = 7 hrs/day

Productivity = total working time (min)/ total picking time needs to complete one order (2).

Table 7 Productivity for each rout

Route	Average Picking Time (hrs.)	Productivity (Order/Person/Day)
S-Shape	320.09	33
Combined	244.45	37
Largest gap	237.55	38
Aisle by aisle	215.36	39
Self-Experimental	380.00	31
Optimal	215.36	39

As shown in (Figure 11), a strong correlation was found between the average travelled distance for each route and the operator productivity.

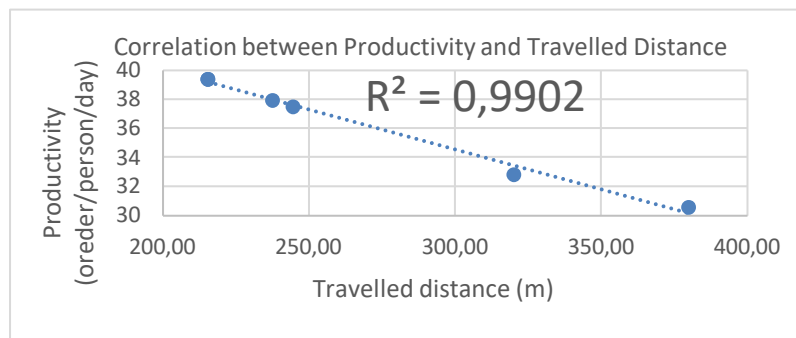


Figure 11 Correlation between productivity and travelled distance

As a result, the routing method the operator use can affect his productivity as shown in (Figure 12).

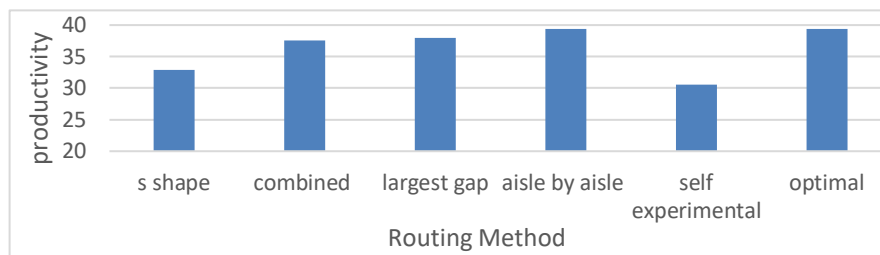


Figure 12 Productivity for each routing method

6 Conclusion

The main aim of this study work was to solve a relevant problem within the field of the logistics sector in general warehouses order picking route activity in particular, showing its influence on labour productivity and its contribution to the retailer warehouse in an emerging economy. Analysing and diagnosis of the current situation of the retailer warehouse order picking route was presented as the main problem the low productivity rate in the processes of storage and picking, resulting in the use of overtime to not affect the level of service to the customer-impacting on the cost overrun. The logistical activity of

picking orders is one of the most important activities that depend on time in most warehouses, and that plays a big role in influencing the entire supply chain. From this point of view, this study provides suitable solutions optimize the route selected for order picking and preparation of different orders for customers in a rectangular warehouse that contains multi parallel-aisle with section aisles in the centre and edge of each aisle. Where this study aims to propose a directive policy that works to reduce the total time and/or shorten the distance travelled in the processes of picking and selecting different requests, which would reduce the total costs and work to raise the productivity of the labour

available in the warehouse. Where this was achieved through the improvement in labour productivity using the simulation method. Two different ways/options adopted based on the order-picking process allocation into the warehouse have conducted the simulation. 12 various pick-order locations were simulated and the simulation delivered routes for various routing policies: S-shape, combined, largest gap, aisle-by-aisle, and self-experimental for both scenarios. The results illustrate that the proposed approaches outperform the S-shape, combined, largest gap, aisle-by-aisle, and self-experimental methods by 29%, 24%, 21%, 19%, and 17%, respectively. The major outcome that can be reached from this conducted study, and based on the obtained results, is that the order-picking process in the warehouse operation needs a high number of laborers. In order to reduce this number labor, utilization must be increased; this research result shows that if the operator was provided with the optimal route to use in the picking process that productivity has increased by 29%. Optimizing order picking as suggested would improve the processes that would run more efficiently. The enhancement includes discovering the optimal route by a simulator that will directly have a positive impact on the consumption of order-picking time. Future research work can be conducted to overcome There are some limitations during conducting the current simulation model. Therefore, some modifications can be made to the simulation that was applied in this study by selecting and defining different locations to accommodate more realistic and actual situations. Moreover, the data can be used and developed by researchers in more complex situations; for example, multiple pickers in relatively large and multi-purpose warehouses, in addition to that other uncertain factors can be introduced, such as bottlenecks that occur in traffic through different paths and errors in operators. Kanban triggers can be taken into consideration by performing random optimization.

6.1 Practical implications of the study

Through the gained results, a time study was made using a stopwatch to define the average picking time of each operator using simulation tool for those routes, there are a number of useful practical implications that can be acquired. It deals mainly with (a) organizational culture, (b) process re-structuring and re-engineering, (c) staff resistance to change, and d) motivation for maintaining the new way of doing business. We can summarize the main implications of the study as follows:

- ✓ Most of the companies and their warehouses need to adopt an effective digital transformation approach in the various logistics functions and move from the system of picking orders in the traditional way to the system of picking according to the future vision, bypassing only the process of updating the current technology used. Where the adoption of new and modern automation tools can result in a state of dissatisfaction among the workforce, and if it is not

managed effectively and correctly, it may result in a failure in investment and a decline in performance. Therefore, it is necessary for companies to alert to increase awareness among employees and workers in them by creating an organizational culture that will raise the level of readiness and readiness to keep pace with rapid technological progress.

- ✓ Process re-structuring and re-engineering Regardless of the need of the companies and their warehouses for the need for organizational culture, the reason for failure may be attributed to the failure to adopt a policy and implement the process of re-structuring and re-engineering operations when necessary and the urgent need for that. Therefore, companies today must determine the necessary needs for their operations and various logistical activities, including the order-picking processes of different customers' requests according to the latest new and adopted technology.
- ✓ Staff resistance to change: most of the workers in the various companies and warehouses tend to resist change by replacing them with technology, due to their natural fear of putting them in the job danger zone. Typical questions are asked to the workforce who work in the logistics sector in general, and to workers in the order-picking techniques in particular when it is directed towards adopting new technologies or systems in order to maintain the workforce in companies and their warehouses and increase awareness of it through successful and effective management. In addition to adopting an effective and continuous training system to keep abreast of various developments in updating systems, which include it will facilitate the tasks and work of the various workers.
- ✓ Adopting a new motivation style for maintaining a new approach to performing the picking order process within businesses and their warehouses: next, perform a multi-level run installation for the order-picking process via simulation, it is crucial to keep the new approach to acting and executing order-picking processes in the business and in its warehouses. Finally, continuous improvement of the order-picking process should be adopted as an approach to preserve the users' interests; thus, their proposals for enhancements from the workforce are crucial with the new systems adopted such as picking order at warehouses.

This study highlights further future research work. While satisfying its goals, the research expanded and identified other possible approaches for optimization. Within the established methodology, there is still room for further optimization, such as zoning, batching and others methods to increase the productivity for the studied or investigated warehouse. Adopting and implementing this methodology, ensuring that the automatic handling process could be recommended instead of manual handling in the studied warehouse. Adding a new technology as light or sound picking for observed warehouse in this case study.

Finally, most of the case study concentrates on a specific order picking situation or decision problem. Therefore, it is not straightforward to apply approaches developed for a specific situation to another situation. General design procedures and global optimisation models of order picking are still lacking.

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Austrian future cubicle: commuting, e-commuting or both?

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Abstract: Austria tries to reach its decarbonisation targets by 2050. The significant attention lies in the carbon intensity of transport, with commuting of particular interest. The paper presents E-Commuting practices that are suitable tools to intervene in these journeys; however, it seems to be difficult. Exploring and understanding the commuting system of everyday lives is crucial. It is through this understanding that alternative avenues for intervention arise, for example into the practice of flexible working models. To understand the influence of e-commuting, the questionnaire via WhatsApp of 685 respondents was conducted, which considered an understanding of work and the commute necessary. The aim of the paper was to explore the workers' routines for in-office days and work-from-home days. The results show that the employees want to work remotely full or in hybrid mode and this trend is going forward. The employees are more productive with flexibility mode – 73.08%; they wish more flexibility in terms of returning to the cubicle – 71.79%; they desire the same amount of time of flexibility and going into the cubicle – 70.51%. Finally, in the case of any flexibility in their current organization, they would consider looking for another job that did not require return to the cubicle with the same salary – 53.85%.

1 Introduction

The return to the cubicle debate continues with different directions and no clear resolution for employers and employees. Modern organizations have seriously considered diversifying their geographical footprint with cubicles closer to their workforce or flexible work models. However, recent data indicate that those organizations that wish to have their workforce back in office in 5 days a week could fail [1]. Generally, the cubicles reached by the cars have filled back up fastest. Based on CBRE [2] survey results, 85% of participants want workforce in the cubicle at least half the time, despite a hybrid policy. But who should determine the required days? Will it force more employees back into the cubicle or will Work from Home (WFM) or hybrid work practices persist? There is no one-size-fits-all solution to the return to cubicle approach but as Beno et al. [3] emphasized “managers should be prepared for incidents, accidents and emergencies by having a magical “Plan B” in place”. It has become increasingly clear that work flexibility increases [4,5] and employees are happier about shortening the week in favour of flexibility, even, if it involves a salary reduction [6]. The authors of the paper are of the opinion that there is a way to join both worlds: commuting and e-commuting. The authors of the paper have a unique opportunity to bring the change in relation to commuting and e-commuting, and this should not be squandered [7,8].

The research questions for this study are as follows:

- How do Austrians travel to work?
- Will Austrians change cars with other practices?
- What is flexible working as a practice?

- In what ways does flexibility relate to commuting?

The authors of the paper firstly discuss the current state of e-commuting, providing definitions and previous research. Next, the methodology is being described. The fourth part of the paper presents the findings. Then follows the section presenting the authors of the paper discussions. Finally, the last section is devoted to their own conclusion.

1.1 E-commuting

Commuting is an important aspect of our lives. In 2021, the rate of regional commuting in Austria in the same region was 3731.4 thousand and 436.6 thousand in another region [9]. Further data indicates that Austrians commuted on average for 26 minutes and 27 km in 2020. In the surveyed region, commuters spend 31 minutes in Lower Austria [10].

Commuting is a daily activity that generates the lowest level of positive affect, as well as a relatively high level of negative affect [11]. The recent study indicates that there is a positive correlation between the indicators of 1-9 minutes and 45-59 minutes of commuting and happiness [12]. An effective transportation system increases productivity and can be seen as the key to shortening commute time. But commuters with longer commuting time report lower subjective well-being [13]. Christian et al. [14] further added that over time long commutes may contribute to obesity and other poor health outcomes. According to Friman et al. [15] satisfaction with daily commute linearly affects both experiential wellbeing and life satisfaction and

that higher satisfaction with daily travel is highest for those that walk and cycle and lowest for those that use public transport. Beño [7] stressed that commuters in Austria preferred cars over public transport.

E-commuting means working remotely on a full-time or hybrid basis. Working remotely reduces travel to the cubicles primarily through modern information and communication technologies. For the purpose of this paper work, the commuters are those who travel into work daily and e-commuters are those who partly work from home and commute or fully work from home without commuting.

Nilles [16] started the research of connection between e-working and commuting. Since then, many other e-working studies have been done [17-21]. De Vos et al. [19] stressed that e-working policies seem to be effective of trying to alleviate congestion and transport-related emissions. It saves time otherwise spent in commuting on a daily basis [22]. Additionally, employees can save considerably by e-working [23].

2 Methodology

This work is based on quantitative primary research using WhatsApp. The main aim of the study was to explore the workers' routines for in-office days and work-from-home days. Therefore, commuters and WhatsApp users were selected to participate in this study as a target audience. The research was carried out from 1st December till 9th December 2022.

For this study, a sample of 685 adults from 22 participating organizations, age 18+ from Lower Austria were asked in German to give their feedback to set questions in questionnaire using WhatsApp. A broad range of companies were surveyed, with respondents drawn from many different occupational groups and from across many industries within the private sector. So far, the participating organizations were recruited through email invitation and the authors' contacts.

All the participants engaging in the WhatsApp questionnaire were fully informed in relation to confidentiality, privacy, sensitivity, and data protection. However, all the respondents were informed that participation was entirely voluntary.

2.1 WhatsApp questionnaire survey

The WhatsApp questionnaire survey included 11 questions designed to examine the role of a range of workforce on in-office days and work-from-home days in relation to commuting. Most of the questions were of a Likert-type format, requiring the respondent to indicate the level of quantity, periodicity, and agreement on a different point scale.

2.2 Data collection

When adapting our methodology to a phone-based strategy, the authors of the paper used WhatsApp as the

discussion platform. This tool is widely used among the Austrians. The questionnaire data plan was activated after a potential participant provided informed consent by sending a text message back to the researchers. The series of short videos explaining, how to respond to questions and interact with participants was provided. The answers of the respondents were filled in excel sheet by investigators.

3 Result and discussion

So, 22 organizations agreed to participate in the survey. The participating organizations were based in Lower Austria (n=22) and represented only the private sector. The distribution of participating organizations by organizational size of employees was as follows: large (≥ 200) 54.55%, medium (20-199) 18.18% and small (≤ 19) 27.27%. A total sample of 685 responded to the study, out of them, 46.42% of respondents were female. The mean age of respondents was 30.3. Most (78.69%) were married or living with a partner. The majority (89.34%) had permanent employment status.

Driving cars is still the most popular commuting method among Austrians. 41.75% of the Austrian households own one car and 31.24% two or three cars (see Table1).

Table 1 How many cars do you own?

N=685	N	%
0	123	17.96
1	286	41.75
2-3	214	31.24
4 or more	62	9.05

However, the survey also found that there is a change in the ownership of cars since the pandemic. 28 respondents (4.09%) sold a car. It means that, in total 151 households do not own any car (total 19% increase). As the tech and automotive industries advanced electrification, households reconsidered buying hybrid or electric cars, 45 respondents bought them (6.57%) as demonstrated in Table 2.

Table 2 Has COVID-19 changed your car ownership?

N=685	N	%
Yes, I changed to hybrid, electric car	45	6.57
Yes, I bought an additional car	26	3.80
Yes, I sold a car	28	4.09
No	586	85.55

The pandemic remade the way Austrians work and commute. The authors of the paper have asked respondents to give an answer about their transportation needs today. 245 (45.88%) still drive a car, 289 (54.12%) combine car and public transport (see Table 3). 74.17% (112) people said they use public transport, 19.21% (29) use bike/scooter and 6.62% (10) walk (see Table 3).

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Table 3 How often do you use the following modes of transportation?

N=534	N	%
Car	245	45.88
Hybrid – car & public	289	54.12
N=151		
Public	112	74.17
Bike	29	19.21
Walking	10	6.62

Interestingly, despite the car dependence, 24.09% (165) the Austrians walk more often since the pandemic, 45.69% (313) about the same amount and only 14.01% (96) less often (see Table 4).

Table 4 Since COVID-19, do you walk more often, less often or about the same amount?

N=685	N	%
More often	165	24.09
About the same amount	313	45.69
Less often	96	14.01
NA	111	16.20

Working remotely saved the Austrians hours of commute time. More than a quarter of Austrians spend more than 30-44 minutes on a one-way commute, just under the 23.65% who spend 10-19 minutes commuting (see Table 5).

Table 5 Before COVID-19, how long took your journey (one way) to work?

N=685	N	%
<10	94	13.72
10-19	162	23.65
20-29	105	15.33
30-44	183	26.72
45-59	36	5.26
60+	22	3.21
No commute/WFM	83	12.12

Before the pandemic, only 48 respondents (7%) worked from home (no commute), during the pandemic there is an increase of 79% (233) and now 83 (12.12%) of them work remotely without commuting (total increase of 42%) as shown in Table 6. It is evident that organizations were able to create culture when part of the staff prefer to be around a lot and part of their staff being around more flexible.

Table 6 Did you work from home (no commute) before COVID-19, during pandemic and now?

	N	%
Before	48	7.00
During	233	34.00
Now	83	12.12
Hybrid	151	22.00

For workers returning to some pattern of the morning commute, the authors asked respondents if they expected their work commute to change. More than one quarter of the Austrians indicated that they expect a change, almost 65% did not expect it (see Table 7).

Table 7 Do you forecast that your work commute to change?

N=685	N	%
Yes	172	25.11
No	445	64.96
I do not know	68	9.93

More than half of them (51.16%) expect that they will drive to work more often, almost one-fifth of them (20.93%) expect to commute less due to the flexibility of their work options. 13.95% expect to walk or bike/scooter more often. Only 12.21% will take public transportation more often (see Table 8).

Table 8 How do you forecast your work commute to change?

N=172	N	%
Drive more often	88	51.16
Commute less due WFM	36	20.93
Walk or bike more often	24	13.95
Take public more often	21	12.21
I do not know	3	1.74

Human beings make decisions based on the options that are placed in front of them. When the respondents were asked about the status of their work model, nearly one-eighth worked remotely, almost one-fifth worked in hybrid working model and 451 respondents worked in cubicles (see Table 9).

Table 9 Are you currently working from home?

N=685	N	%
Yes – no commute	83	12.12
Yes – hybrid	151	22.04
No	451	65.84

Employees want to work remotely full or in hybrid mode going forward. The respondents (N=234) were asked to what extent they agree or disagree with the following statements:

- I am more productive with flexibility mode – 73.08%.
- I wish more flexibility in terms of returning to the cubicle – 71.79%.
- I desire the same amount of time of flexibility and going into the cubicle – 70.51%.
- No flexibility is in my current organization, I would consider looking for another job that did not require return to the cubicle with the same salary – 53.85%.

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12.12% (83) respondents are the opinion that all at home seems to be the right mix of working model, 151 (22.04%) prefer splitting at home and at the cubicle, 451 (65.84%) think that all at the cubicle is the right mix of working (see Table 10).

Table 10 WFM, hybrid or on-site, what is the right mix of working?

N=685	N	%
WFM, no commute	83	12.12
Hybrid	151	22.04
On-site	451	65.84

Driving cars is still the most popular commuting method among Austrians. Abrahamse et al. [24] data demonstrate that the more respondents felt able to reduce car use for commuting and the less favorable their attitude toward car use, the less often they tended to drive to work. This is in the line of obtained results from this study where 151 households do not own any car (total 19% increase).

Interestingly, the mode of transportation in Austria still does not lead to sustainable development. Comparable to Guth et al. [25] study where an increase of cross-municipality commuting volumes as of the commuting distances can be observed. 245 (45.88%) still drive a car, 289 (54.12%) combine car and public transport. 74.17% (112) people said they use public transport, 19.21% (29) use bike/scooter and 6.62% (10) walk. This may concur with the widespread use of mobile phones on public transport nowadays, which indicates that commute time is often used by people to communicate with their friends and family [26]. Interestingly, despite the car dependence, 24.09% (165) the Austrians walk more often since pandemic, 45.69% (313) about the same amount and only 14.01% (96) less often. Due to a shift from private motorized transportation to more active transportation, this can, among other things, deliver significant health benefits [27].

With the cost-of-living, energy crisis attacking the Austrian workforce from all angles, maybe working from home will be costlier than commuting in. However, working remotely saved the Austrians hours of commute time. Similar to Beño [28] results study. More than a quarter of Austrians spend more than 30-44 minutes on a one-way commute, just under the 23.65% who spend 10-19 minutes commuting. Almost in accordance with the recent study which indicates that there is a positive correlation between the indicators of 1-9 minutes and 45-59 minutes of commuting and happiness [7].

Hajal [29] highlighted that teleworking's popularity was rising. This confirms the collected data from this study. Before the pandemic, only 48 respondents (7%) worked from home (no commute), during the pandemic there was an increase of 79% (233) and now 83 (12.12%) of them work remotely without commuting (total increase of 42%). It confirms Beno and Hvorecky [28] statement

that e-working and the home office are not just a solution to a crisis.

According to the survey respondents, willingness to work remotely full or in hybrid mode is going forward. Those e-workers feel being more productive. Comparably to Bloom et al. [30] and Beno and Hvorecky [28] study. No flexibility in current organization, 53.85% of employees would consider looking for another job that did not require returning to the cubicle with the same salary. The recent study highlights that after their move to home offices, the employees are prepared to accept a pay cut. There are differences among countries, but two interesting outcomes were noticed in the studied countries:

1. The higher age, the greater the readiness to accept a cut;
2. The smaller the cut, the greater the readiness to accept it [6].

Further other survey shows similar data [32].

12.12% (83) respondents are the opinion that all at home seems to be the right mix of working model, 151 (22.04%) prefer splitting at home and at the cubicle, 451 (65.84%) think that all at the cubicle is the right mix of working. These data are on the lines on Cushman & Wakefield [31] survey where on average 2.7 days on office and, 2.3 days at home.

4 Conclusions

Different types of transport are key accelerators for the development of population mobility [33]. For many, commutes are time-consuming experiences. The trip from home to work and back is therefore an important aspect of modern life, affecting commuters' well-being. The development of the transport system is essential for the economic development of the country [34].

- How do Austrians travel to work?

Whether you live in the city or must drive in from the country almost all Austrians have to deal with some type of commute. In fact, based on received data, cars still dominate in transportation. A daily commute is an essential factor in lives of Austrians. 245 (45.88%) still drive a car, 289 (54.12%) combine car and public transport. 74.17% (112) people said they use public transport, 19.21% (21) use a bike/scooter and 6.62% (10) walk.

- Will Austrians change cars with other practices?

The past years have not changed, Austrians still love cars. However, the survey also found that there has been a change in the ownership of cars since the pandemic. 28 respondents (4.09%) sold a car. As the tech and automotive industries advanced electrification, households reconsidered buying hybrid or electric cars, 45 respondents bought them (6.57%). More than one quarter of the Austrians indicated that they expect a change, almost 65% did not expect it.

- What is flexible working as a practice?

Nearly one-eighth worked remotely, almost one-fifth worked in hybrid working model and 451 respondents worked in cubicles. The employees want to work remotely in full or in hybrid mode and it is going forward.

- In what ways does flexibility relate to commuting?
 - I am more productive with flexibility mode – 73.08%.
 - I wish more flexibility in terms of returning to the cubicle – 71.79%.
 - I desire the same amount of time of flexibility and going into the cubicle – 70.51%.
 - No flexibility in my current organization, I would consider looking for another job that did not require return to the cubicle with the same salary – 53.85%.

As a limitation to this study, it should be noted that we have used a retrospective measure of e-commuting use behaviour only in Lower Austria. This did not allow the authors of the paper to fully test it. Further, a native language questionnaire with an extensive vocabulary and mastery of the language allows the respondents to express themselves but may limit the interpretation when translated into English. A multi-country survey may potentially be part of the further investigation. Furthermore, costs analysis whether to commute or working from home represents future topic interests.

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Austrian future cubicle: commuting, e-commuting or both?

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Assisting artificial intelligence adoption drivers in human resources management: a mediation model

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Abstract: This study investigates the artificial intelligence (AI) adoption drivers and the mediating effects of trust and how the latter influence human resources management (HRM) of the banking sector in Saudi Arabia. A survey-based questionnaire was employed to collect data from 261 practitioners and professionals working in different banks in Saudi Arabia. Partial least squares structural equation modelling (PLS-SEM) was used to analyze data. Significant and positive effects of perceived usefulness and trust on artificial intelligence adoption in human resource management are highlighted by the results. In addition, the indirect effects of trust between perceived usefulness and AI adoption in human resource management were also found to be significant.

1 Introduction

In the age of globalization and fast technological advancement, organizations have prioritized human resources as a way to obtain a competitive advantage and long-term sustainability [1,2]. By way of these systems, many businesses have refocused their attention on adopting new technologies to enhance their performance [3] and aligned their strategies to enhance overall performance as a consequence of the increasing adoption of those technical tools, such as human resources information system (HRIS) and artificial intelligence (AI) applications [4,5]. Accordingly, HRIS has ostensibly evolved into artificial intelligence, enabling organizations to significantly improve their performance and productivity, perform specified human resources functions, analyze data and assist human resources departments to focus on their primary responsibilities. The adoption of AI in an organization claims that patterns of HR practice, rather than single actions, are required to meet organizational goals [6]. Nonetheless, AI has recently gained a reputation as a more strategic tool, linked with organizational values, goals and visions [7,8]. Additionally, several studies have addressed AI in HRM from different perspectives, specifically the qualitative differences that are to be expected at the level of HRM skills and competencies, both prior to and after the implementation of AI within an organization [9]; the challenges and opportunities associated with the adoption of AI in HRM [10,11]; the impact of employee commitment and trust as regards the adoption of AI [9]. In particular, the study examined a range of factors identified by previous research based on the analysis of the theoretical literature which included trust, perceived usefulness, user behaviour, ease of use and infrastructure.

Based on that and according to the analysis of the previous literature, companies have begun to place a greater emphasis on AI and different technical tools through which they may develop organizational performance and compete accordingly, in order to achieve a variety of benefits. Integrated entities, information accessibility, the capability to analyze big data and notification systems are common examples of these benefits, which attempt to create a highly competitive advantage and added value for operations [12-14].

However, in the banking sector in Saudi Arabia, there are various challenges that need to be addressed in terms of human resources management. The implementation of artificial intelligence (AI) in this sector can bring about significant improvements in terms of efficiency and productivity. However, like other technology, the adoption of AI requires the strict implementation of quality principles and practices. According to [6] the banking sector in Saudi Arabia needs robust improvement and national preparedness to counter financial emergencies in the future not to repeat the sufferings that had damaged the whole society financially, physically, and emotionally. Therefore, it is high time to integrate and implement best managerial practices, principles, and approaches for creating agility in the banking sector of Saudi Arabia. Given the rapid growth of banking sector in Saudi Arabia, this study exists to fill this gap.

Accordingly, this study argues that there are many drivers affecting the adoption of AI in the HRM in the bank sector in Saudi Arabia. Those factors include ease of use, perceived usefulness, infrastructure, along with trust. However, the researchers attempt to establish a model by means of mediation relations across study variables to address gaps in the current literature. Furthermore, this

research contributes to the area of HRM in the Saudi banking sector by analysing the current literature more thoroughly and examining the mediation effect of trust and user behaviour. The rest of the article is structured as; the second section comprises the theoretical background of the study, and the third and fourth sections encapsulate the methodology, and results. While sections five and six are the discussion and conclusion sections.

2 Literature review and hypothesis development

Each organization, whether small or large requires human capital to be able to conduct business and achieve its goals. Human resources comprise personnel that is employed in an organization to perform their daily tasks in exchange for a salary or rewards. Besides, the creativity of employees is becoming increasingly imperative to the success of a business and its long-term sustainability [15]. Conversely, HRM refers to a set of professional practices which include a range of personal practices that can be combined to ensure that an organization has a professional approach to managing people. These practices might include training and supporting qualified workers through stages beginning with selection and recruitment and including compensation and motivation [6].

HRM is critical in motivating employees to achieve the highest level of productivity and efficiency in today's business world. However, this may possibly require the adoption of AI technology to ensure agile operations have the best possible tools and to be a high-tech company compared to rapid world innovation and revolution. In fact, the relationship between businesses, employees and customers is fundamentally changing as a result of the fast-paced expansion and widespread deployment of Artificial Intelligence (AI) and other ground-breaking technologies. It should be noted that AI is referred to as "computer intelligence," "human intellect emulation" or "mind machine" [9]. [16] defined AI as "the science and engineering of constructing intelligent machines". According to [17] and [18], the primary principle of AI is that automated equipment, for instance, machines, robots and software can perform everyday jobs that have typically been undertaken by people. In other words, AI refers to using technology to perform a task that requires some level of intelligence to be accomplished [19]. Moreover, the adoption AI is particularly useful for businesses as it can foster more productive coordination and cooperation. Likewise, the adoption of such a tool offers several opportunities to improve and reduce the cost of HRM tasks [20].

Specifically, AI can reform the structure of HRM and be an integrated system that delivers excellent results with the aim of enhancing performance management, workforce planning, people analytics, virtual assistants for self-service/HR service delivery, career patching, leadership, and coaching [21]. AI creates accurate and trustworthy

information databases via the use of algorithms by enabling instant access to data and rapid transmission which enhances human resources [22]. The ability of AI to promote individual workplace learning through a crucial aspect of database management [23]. Consequently, the manager has access to all records and can use them whenever necessary. It also supports decision-makers through the use of big data and machine learning algorithms [24]. Additionally, fostering organizational learning and eventually improved knowledge management enables businesses to derive valuable insights from individual behavior. Besides, [25] provides a piece of evidence for the transformational outcomes of AI in HR functions. [26] pointed out that AI has a significant positive influence on employee performance and work engagement.

In practice, AI aids the HRM process in a variety of ways. Database management is offered to support individualized workplace learning [27], using big data techniques and machine learning. It offers an inclusive approach to handling hiring, training, development of employees, and performance reviews [28], AI also provides intuitive decision-making [24] whilst AI's capacity to build a substantial library of knowledge, process and history that HR managers may consult and use as required is invaluable [23].

More generally, AI is changing how businesses manage their staff, develop HR calendars and assess productivity. As AI offers new approaches, such as social robots for HRM, they open up several opportunities and assist different HRM services [20]. Several scholars support this argument and highlight the ways in which computer-based software and AI tools facilitate the organizational setting and enhance productivity levels [29].

Many recent studies have discussed the adoption of AI drivers within the context of HRM and have questioned factors that affect the adoption of AI in HRM. [30] identified three primary drivers that influence the adoption of AI in HRM including technological, environmental, and organizational context factors. However, [22] extended the classification of these factors to include organizational preparedness, perceived benefits, and technical expertise. Moreover, [31] provided systematic classifications of these factors including effort expectancy, facilitating condition, performance expectancy, perceived credibility, along with social influence. Issues and drivers that affect the adoption of AI, as mentioned in previous studies, include technical or performance-related factors, organizational or environmental factors and user-customer factors. These studies have primarily focused on one or a few of these factors. This study seeks to investigate other factors including ease of use (EOU), perceived usefulness (PU), infrastructure, trust, as well as user behavior (UB).

The first driver in this study pertains to ease of use (EOU) which refers to the extent to which a product can be used by individual users to achieve specific objectives, both effectively and satisfactorily [32]. [33] asserted that EOU is directly related to a person's perception of the effort

required to operate a system and is a key component of perceived ease of use. It is important to mention that EOU could be extremely important in determining the acceptance of AI from the perspective of the user on account of the unique nature of AI, which demands a certain level of knowledge and expertise. Various previous investigations have provided empirical evidence for this argument [34-36]. Similarly, EOU is preferred and included among the suggested conceptual model for a particular reason. Practically, the results of using AI applications have been widely considered as having a high degree of complexity and ambiguity [37-39]. Therefore, it was plainly noted that EOU might be one of the most crucial factors that might significantly influence whether Saudi Arabia's banking industry decides to implement AI applications. From the above discussion, it can be hypothesized that:

H1: Ease of use has a significant impact on the adoption of AI applications in HRM in the banking sector in Saudi Arabia.

One of the criteria applied in the study relates to perceived usefulness (PU). This is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” [33]. In the previous literature, PU has been identified as one of the most influential drivers for managers to adopt AI [29,40-42]. Accordingly, it could be argued that users of the banking system who have adequate skills and believe in the benefits of AI applications are more likely to perceive AI as beneficial in their work. From an HR standpoint, workers must receive adequate training and information to better comprehend the advantages and anticipated results. By doing so, the perceived usefulness of the technology will increase and, in turn, this will influence the adoption of AI [35,37]. From the above discussion, it can be hypothesized that:

H2: Perceived usefulness has a significant impact on the adoption of AI applications in HRM in the banking sector in Saudi Arabia.

In the context of a corporate IT environment, infrastructure refers to the collective hardware, software, network resources, and services that are necessary for the existence, operation, and management of the environment [43-45]. Infrastructure systems will be crucial in supplying and maintaining services for this ever-increasing demand as AI applications become more connected, complicated, and digitalized [46]. [47] determined that without the

critical infrastructure in an organization and without a high level of readiness, AI applications will fail. From the above discussion, it can be hypothesized that:

H3: Infrastructure has a significant impact on the adoption of AI applications in HRM in the banking sector in Saudi Arabia.

The feature that attracts or impedes a user from adopting AI apps is trust, which is vital in regard to promoting the adoption of AI. In his definition of trust, [48] explained that it is "a confidence or anticipation about the other party or as a behavioral intention or desire to depend on or rely on another party, coupled with a sense of vulnerability or danger if the trust is violated. From the viewpoint of the user or HRM, trust is described as the user's expectations of how the AI applications may provide opportunities and guarantees [49]. [50] ascertained that the creation of trust between people depends significantly on the trustee's outward look and that the embodiment of AI will quite possibly play a significant role in building that trust between people and AI applications. Accordingly, trust may be cognitive (based on reason) as well as emotional (based on affect), [51]. In this study, we will concentrate on trust as an emotional effect.

Numerous previous researchers have demonstrated the practical influence of trust on the acceptability of IT, AI and technological applications [52-54]. In this study, we addressed the mediation role of trust between EOU, PU, infrastructure and the adoption of AI in HRM. In their investigation of the mediation role between PU, EOU and purchase intention, [55] determined the significance of this relationship. Nevertheless, we contend that infrastructure, PU and EOU are crucial in raising user's trust levels and as a result, act as a dynamic construct that may persuade users to adopt AI applications. From the above discussion, it can be hypothesized that:

H4: Trust mediates the relationship between EOU and the adoption of AI applications in HRM in the banking sector in Saudi Arabia.

H5: Trust mediates the relationship between PU and the adoption of AI applications in HRM in the banking sector in Saudi Arabia.

H6: Trust mediates the relationship between infrastructure and the adoption of AI applications in HRM in the banking sector in Saudi Arabia.

H7: Trust has a significant impact on the adoption of AI applications in HRM in the banking sector in Saudi Arabia.

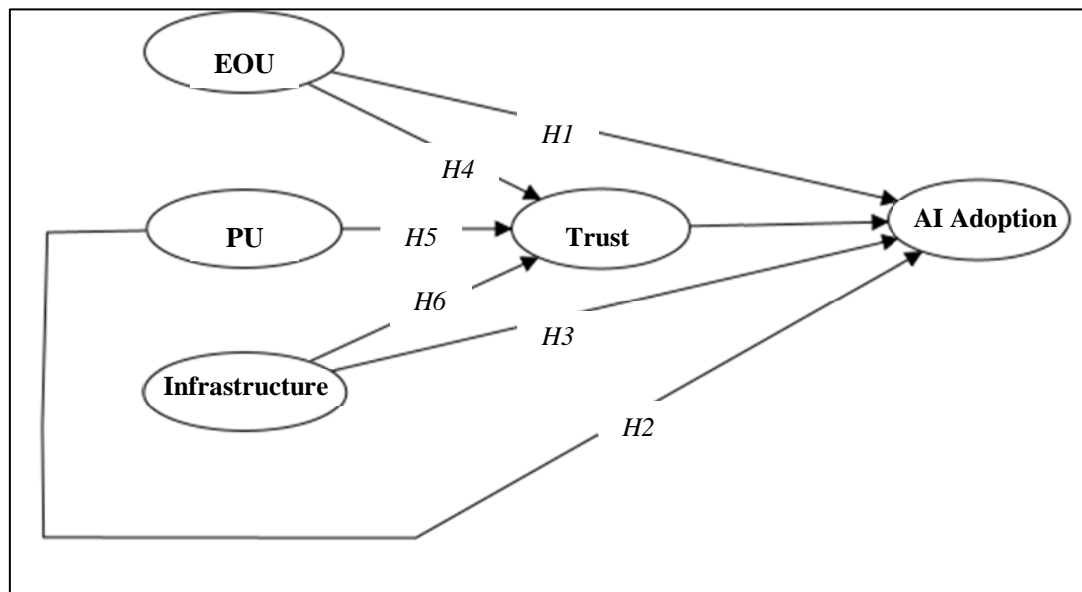


Figure 1 The research model

3 Methodology

A quantitative technique was used in this study to obtain quantitative results and a level of significance reflecting the impact of AI adoption drivers in human resource management and the mediating role of trust. A survey-based questionnaire was used to gather data. The survey consisted of four primary constructs in the questionnaire, each with a validated instrument from previous studies. A five points Likert scale was used. To collect data, banks in Saudi Arabia were selected and their human resource departments were contacted to outreach the potential participants. The emails of the potential

participants were taken and an online survey using Google forms was undertaken. a convenience sample technique was applied. We were able to collect 261 completed questionnaires, which is an adequate sample size for the kind of data analysis applied in this study. Structural Equation Modelling (SEM) using smart PLS was used to analyse the research data. PLS-SEM is an efficient technique to investigate the interrelation among multi-item constructs [56,57]. Table 1 summarises the characteristics of the sample, highlighting the variation in the respondents' gender, ages, levels of education, work experiences and hierarchical positions.

Table 1 Sample characteristic

Category	Items	Count	%
Sex	Male	136	0.521
	Female	125	0.479
Age	20 to 35 years	60	0.230
	36 to 50 years	180	0.690
	51 years and above	21	0.080
Education Level	Diploma or less	59	0.226
	Bachelor's	125	0.479
	Postgraduate (Master and PhD)	77	0.295
Experience	< 2 years	50	0.1916
	2-5 years	70	0.2682
	6 to 10 years	75	0.2874
	>11 years	66	0.2529
	Total	261	100%

The majority of the study participants were males (52.1%). Most of the participants were aged 36 to 50 years and had Bachelor in qualifications. In terms of experience, the majority (28.74%) had experience between 6 and 10 years. While 32.8 % were serving in managerial positions.

3.1 Measurement model

Assessments of measurement models are made in light of construct validity through internal consistency, reliability, and discriminant reliability [58,59]. To determine the construct validity, the factor loading values

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of all of the items must be greater than 0.6) which is the case for all the items [60]. (See Table 2). Likewise, the construct's reliability was then evaluated using Cronbach's alpha and the composite reliability with a cut-off value of

0.7. To confirm the convergent validity of all the constructs, the average variance extracted (AVE) for each construct must be more than 0.5 [61]. These requirements are all satisfied, as evidenced by the findings in Table 2.

Table 2 Construct validity

Constructs	Items	Loading	Mean	SD
Ease of use (EOU) (Cronbach's α = 0.871; CR=0.903; AVE=0.609)	Q1	0.815	4.286	0.795
	Q2	0.780	4.186	0.816
	Q3	0.853	4.286	0.831
	Q4	0.801	4.01	0.878
	Q5	0.651	4.314	0.645
	Q6	0.768	4.271	0.716
Perceived Usefulness (PU) (Cronbach's α = 0.825; CR=0.877; AVE=0.589)	Q7	0.725	4.471	0.691
	Q8	0.809	4.471	0.626
	Q9	0.694	4.414	0.597
	Q10	0.804	4.414	0.643
	Q11	0.799	4.386	0.639
Infrastructure (Cronbach's α =0.835; CR=0.873; AVE=0.634)	Q12	0.833	4.257	0.578
	Q13	0.620	4.057	0.826
	Q14	0.830	4.186	0.816
	Q15	0.803	4.029	1.069
	Q16	0.667	4.343	0.826
Trust (Cronbach's α =0.803; CR=0.873; AVE=0.634)	Q17	0.829	4.157	0.822
	Q18	0.663	4.271	0.773
	Q19	0.848	4.129	0.809
	Q20	0.832	3.971	0.878
AI Adoption (Cronbach's α =0.862; CR=0.895; AVE=0.551)	Q21	0.821	4.329	0.712
	Q22	0.721	4.271	0.754
	Q23	0.782	4.257	0.805
	Q24	0.635	4.343	0.652
	Q25	0.776	4.186	0.961
	Q26	0.665	4.529	0.626
	Q27	0.778	4.643	0.535

The heterotrait-monotrait ratio test (HTMT) and Fornell and Larcker's (1982) criterion were then employed to assess the discriminant validity. The Fornell and Larcker test initially suggests determining whether each construct's

AVE square root of AVE is larger than its association with other variables [59]. (Hair et al., 2017). The variables' HTMT values must subsequently be less than 0.9 [58]. Table 3 displays the results of the discriminant validity.

Table 3 Discriminant validity*

	AI Adoption	EOU	Infrastructure	PU	Trust
AI Adoption	0.742				
EOU	0.590	0.781			
Infrastructure	0.379	0.647	0.756		
PU	0.630	0.725	0.414	0.768	
Trust	0.686	0.577	0.550	0.552	0.796

*The square root values of the (AVE) are in bold in the diagonal cells. Below, we present the values of correlations between the constructs. The heterotrait-monotrait ratio scores are inserted above the diagonal cells.

3.2 Structural model assessment

The assessment of a structural model includes determining the model's level of quality. We made use of common methods, such as the R2 coefficient and the

standardised root mean squared residual (SRMR) score, to evaluate the model's predictive accuracy indicators. Additionally, the SRMR statistics need to be lower than 0.08 to confirm that the proposed model fits the data

[60,61]. The findings reveal that the R2 for AI adoption is 0.545, whilst for trust, it is 0.435. The SRMR is 0.057 which demonstrates adequate scores for both indicators.

3.3 Hypotheses testing

The results of the hypothesis tests based on the PLS structural model analysis are explained in Table 5. Following the recommendations of [62]. A bootstrapping approach was used to produce reliable coefficient estimates with 5000 subsamples.

Table 4 Hypotheses test

Path Relationships	(β)	Standard deviation	T Statistics	p-values
Hypothesis 1				
EOU → AI Adoption	0.189	0.166	1.138	0.255
Hypothesis 2				
PU → AI Adoption	0.272	0.155	2.753	0.040
Hypothesis 3				
Infrastructure → AI Adoption	0.129	0.120	1.078	0.281
Hypothesis 4				
EOU → Trust → AI Adoption	0.064	0.092	0.691	0.490
Hypothesis 5				
PU → Trust → AI Adoption	0.159	0.074	2.138	0.000
Hypothesis 6				
Infrastructure → Trust → AI Adoption	0.166	0.104	1.603	0.109
Hypothesis 7				
Trust → AI Adoption	0.497	0.152	3.277	0.001

According to hypothesis (1), the EOU has a positive and significant impact on the adoption of AI. The result did not support this prediction ($\beta = 0.189, p > 0.05$). H.1 is therefore rejected. According to hypothesis (2), PU significantly and positively influences the adoption of AI. The results support this prediction ($\beta = 0.272; p < 0.05$). H.2 is therefore accepted. Hypothesis (3) predicts that infrastructure has a positive and significant influence on the adoption of AI. The result does not support this prediction ($\beta = 0.129; p > 0.05$). Thus, H.3 is rejected.

Furthermore, H4, H5 and H6 predict that trust mediates the relationship between EOU, PU, infrastructure and AI adoption. The findings provide evidence that just one path that includes the trust factor between PU and the adoption of AI ($\beta = 0.159; p < 0.05$) is accepted. Consequently, H5 is supported while H4 and H6 are not supported. Finally, H7 predicts that trust has a direct impact on the adoption of AI. The findings support and provide evidence for this prediction ($\beta = 0.497; p < 0.05$). As a result, H7 is supported.

4 Results and discussion

To recap, the research question in this study focused on assisting the adoption of AI drivers in HRM in the Saudi banking sector. The mediation role of trust is also investigated. The findings attributable to the PLS-SEM analysis on data collected from 261 practitioners at various

Saudi Arabian banks revealed that PU and trust have a direct impact on the adoption of AI.

The analysis findings are in line with earlier publications. PU (H2) plays a significant role in motivating HR professionals and decision-makers in banks to adopt AI applications [35,37]. Similar to this, previous research supports the importance of trust in the adoption of AI (H7). [50] pointed out that establishing a technological culture within banks that will increase user acceptability and allow management to reduce errors and boost performance [52,53].

Likewise, the mediation effects of trust on the relationship between PU and the adoption of AI was ascertained to be significant and positive (H5). This result indicates the fundamental role trust plays in promoting the adoption of AI among users in the banking sector in Saudi Arabia. The association between the adoption of PU and AI was also determined to be significantly and favourably mediated by trust (H5). This conclusion emphasises how important PU is in boosting user confidence and encouraging the use of AI technologies in Saudi Arabia's banking sector.

Accordingly, the numerous theoretical and managerial implications gained from our research can be presented as follows. By identifying the key factors influencing user adoption in the banking sector in a developing nation (Saudi Arabia), this study makes a significant contribution

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to the field of AI in HRM. The research presents PU and trust as efficient antecedents of AI adoption in HRM and as a result, generates additional insights to the existing literature on AI (e.g., [12,22,30]). This research contends that rather than focusing on the direct influence of trust on the adoption of AI, management should concentrate on emphasizing the expected advantages of such applications. This can be achieved by actively involving employees in such practices, besides developing a continuous improvement policy before providing employees with instructions related to how to use AI applications. This demonstrates how trust between PU and the adoption of AI has an indirect effect.

Additionally, this study highlights the importance of PU and trust, which can provide practitioners and decision-makers with beneficial information concerning banking sector practices when implementing AI in HRM. As a result, the findings are in favor of PU's active involvement in promoting the adoption of AI. Top management has to understand the value of PU and how banking institutions may use it to develop HRM and AI application integration policies that keep pace with developments in IT.

One significant benefit of AI applications in human resource management in the banking sector is its potential to improve efficiency in various HR processes such as recruitment, selection, and performance evaluation. AI-based recruitment systems can help banks to identify suitable candidates, thereby reducing recruitment time and costs. Additionally, AI can help to analyze employee data to identify patterns and insights that can inform performance evaluation and training needs. These benefits have been supported by several studies, including [18,21,28] which showed that AI applications improve recruitment efficiency and employee performance in the banking sector. Studies such as [2,18] have provided recommendations on how banks can effectively adopt AI applications in their HR processes to maximize the benefits and mitigate the risks.

By doing this, banks in developing nations like Saudi Arabia will improve their AI in HRM results and customer satisfaction levels regarding adoption preparedness. The results of this study assist managers to recognise the significance of their dedication, PU, and trust in influencing the banks' adoption of AI and in comprehending the significant function of those drivers, with the aim of increasing the quality of HRM through the adoption of AI.

5 Conclusion

The main first contribution of this study to theory is providing evidence that EOU and PU in the banking sector enhance AI adoption in human resources management. Secondly, practicing the role of trust as a mediator factor for increasing AI adoption. These findings support that trust is a dynamic factor required for optimizing AI within the banks' operations. However, these findings are consistent with [32,42] who pointed out that banks that

have more awareness among employees and PU with EOU as AI features will be reflected in their effects on their HRM performance. The results of this study show that trust can achieve by PU and EOU with different supporting claims about the importance of these enablers [40,45]. Since this study revealed that PU and EOU have a positive effect on trust when implementing AI in HRM, it follows that if an organization has higher levels of PU and EOU, it will be better able to identify and manage the potential risks in the AI, resulting in a more effective and responsive mechanism. Similarly, the positive impact of PU and EOU leads to an increased level of trust if an organization is better equipped to AI implementation exploration and exploitation in its banking activities. However, it must be considered that this correlation does not imply causality as numerous can be factors that might impact this relationship between AI adoption and HRM. Future research could examine the impact of AI on employee performance in more detail. This could include identifying which job functions are most affected by AI and how employees react to working alongside AI tools. Besides, future research can also address employee attitudes towards AI, including how comfortable they are working alongside AI tools and how they perceive the impact of AI on their job security.

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