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The Impact of Internal Logistics on the Performance of Manufacturing Companies - A Review Article

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Abstract:
Research Question (RQ): What is the impact of quality implementation of internal logistics processes on production performance?
Purpose: Determine which organization of internal logistics is best suited to production success and what approaches improve the quality of organization of internal logistics processes.
Method: Results will be sought by reviewing articles and existing literature from the past few years. We will focus primarily on the latest literature because the review article describes the changes that began in the 4.0 industry era.
Results: The organization and investment in the processes of internal logistics in production affects the quality of production and thus, the competitiveness of companies. The results are intended to illustrate options that help us improve our internal logistics processes.
Organization: The results contribute to make the right decisions in the organization of logistics processes within production and to make the right inputs from management into improvements and advanced technologies for the implementation of logistics processes.
Society: The lower costs that is achieved with the proper organization of internal logistics in production represent a great competitive advantage for the organization, at the same time, we are burdening our employees with the introduction of advanced technologies.
Originality: A comprehensive review of existing recent literature on the impact of proper planning, organization, and manner of performing internal logistics on production performance in companies.
Limitations / further research: The analysis will still be limited due to the limited number of literature and articles.

Keywords: internal logistics, production, performance, improvements, technology.

1 Introduction

"The logistics function in a company is usually only treated as a support function, and its impact on overall business performance is not fully recognized. In order to successfully improve internal logistics activities, we need to change the way we look at this area and its operation." (Granlund & Wiktorsson, 2014, p. 550)

Logistics has a significant impact on the competitiveness and economy of manufacturing companies. Changes, market development, globalization and many other factors increase the demands for the implementation of logistics processes. This also applies to the field of internal logistics in production, which must ensure a successful flow of materials and

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information. Internal logistics is a key element of an organizations' success. Industry 4.0 brings a great del of significant changes in production with an emphasis on the interaction of machines and people, which will result in a faster and more efficient production system (Fusko, Rakyta, & Manlig, 2017, p. 213–214).

Internal logistics includes activities within the physical framework of manufacturing companies. It is about planning, organizing, and controlling all activities of moving goods and warehousing within companies, in order to optimize production. The elements of internal logistics are workforce, internal transport, transport routes, means of transport and equipment, warehouses and warehousing, and all logistics services that bring significant added value. We can emphasize the importance of appropriate means of transport and equipment in the service of internal transport, where it is important to organize internal transport properly, storage and handling operations (loading, unloading, moving, palletizing, containerization, packaging, unpacking). The basic principle of internal logistics is to make the best use of space and shorten the routes and time of material flow (Jakomin & Veselko, 2004, p. 19–21).

The purpose and goal of the research were to determine how the correct organization of internal logistics affects the success of the production process and what are some suitable approaches that would benefit internal logistics processes. By reviewing the literature, we will learn how to improve the organization of internal logistics and what are the main factors that bring success in manufacturing companies. We will focus mainly on approaches that improve the performance of manufacturing companies through the proper implementation of internal logistics processes. The result showed the possibilities for improving processes in internal logistics, which could reduce costs, improve flow and respond faster to market changes, thereby affecting the performance and competitiveness of manufacturing companies. The results could be useful for improving internal logistics procedures and thus the performance of manufacturing companies.

2 Theoretical framework

Internal logistics as a science and as an activity is based on the development of logistics processes, and logistics phenomena that are important for efficient and successful implementation within the tasks of individual business functions. The field of internal logistics is limited, and the logistics phenomena it deals with can be placed among the phenomena related to its internal resources, potentials and capabilities. Internal logistics emphasizes the flow of materials, energy, capital, information and people within the company. These are based on the integration and suboptimization of internal logistics subsystems or other subsystems of the organization and contribute to optimizing the organization's operations and efficiency. The concept of internal logistics is focused on the dynamics and goals of the company as a whole, so the systematic approach contributes to the implementation of synergy measures to reduce total costs (Zelenika & Pupovac, 2001, p. 354–378).

Internal logistics represents all activities aimed to control the flow of material in the production process. Emde and Boysen (2012, p. 393–402) break it down into the following activities: production planning, inventory management, supply, material handling, and providing transitional information.

Production logistics is the most complete corporate logistics system; materials and production tools required for production processes, the harmony of the production process and its sub-processes, and the flow of materials and related information flow processes are necessary to ensure that consumers get products from production. As the competition on the market grows, companies can only hope to maintain their market position by seizing opportunities for integration in-between production management and logistics. The efficient functioning of logistically integrated production management also means an integrated information system. Logistically integrated production management takes into account the level of stocks of finished products, manages data from product design and production technology, and process planning (i.e., the order of activities and technical data, technological equipment for activity), determines material demand and production capacity needs. A further step in production planning is planning, which also takes into account inventory levels and logistics capacity. Production planning as a whole also reveals that in addition to production resources, logistics resources are also taken into account and optimized. The purpose of logistics-oriented production processes is to create a structure of production organization that will solve logistics principles as comprehensively as possible and thus significantly increase an organization's competitiveness. Proper management of production logistics processes is vital for the cost-effective operation of companies, as it can affect an organization's business performance and customer satisfaction. (Nagy, Illés, & Bányai, 2018, p. 4–6).

Kartning, Grösel, and Zrnic (2012, p. 193–194) say that the history of internal logistics dates back to the post-war period when economic and industrial development was mainly driven by production. Transport in the factories was initially carried out with the assistance of simple equipment such as sack trolleys, other handcarts, and overhead cranes. The goods were stored at ground level, as storage on the floors was useless due to poor visibility and accessibility. This situation began to change in the early 1950s under the influence of newly developed modes of transportation in the United States. New items were introduced, such as pallets as universal loading units and forklifts, which enabled the U.S. military to effectively conduct logistics operations between the two world wars and the Korean War. The introduction of standardized loading units in the form of containers and pallets has stimulated the development of forklifts and elevators. Pallet storage racks helped save space and make it easier to access stored goods. Standardization of the 800x1200 mm pallet is introduced, which is the key to further standardization of logistics equipment and systems. The 1960s were a period of strong economic growth, production expanded rapidly, as did distribution and international trade. The economic boom is increasing labour costs, which management is aware of and is looking for ways to operate the whole businesses efficiently, not just production processes. There is a need to rationalize storage facilities, which must represent an

efficient space between the various stages of production and flexibility with the final market. The 1960s thus marked a period of rapid progress in storage technology. The first automated twenty-meter-high warehouse was built in 1962 in Germany, which encouraged the automation of transfers and processes for computer storage and thus resulted in lower storage costs. In the 1970s, production and distribution were shaped by the consumer with demands for quality products and a more comprehensive range of products at reasonable prices. Demand has become more complicated, so organizations have increasingly invested in automated warehouses, equipment for performing production processes, development of distribution centres and new technologies such as AGV (Automatic Guided Vehicle) and new approaches in the field of electronics and information technology. The economic situation in the early 1980s triggered the need for flexible production modelled on Japanese methods, which lead to factory leaders to begin to view production as a unit of internal and external processes. The just in time (JIT) philosophy was introduced, which depended mainly on appropriate information systems and communication technologies, and internal logistics marked by the introduction of bar code systems. Since the mid-1980s, computer systems and later lean production have played a significant role, while organizations were striving to introduce the use of lighter, more efficient, and faster cargo handling devices into logistics systems. Technologies based on wireless communication are introduced into the processes and in internal logistics, mainly in the field of AGV use, while radio frequency identification (RFID) technology is becoming increasingly important, which enabled information support of goods and devices and significantly overtook the set of barcode functions.

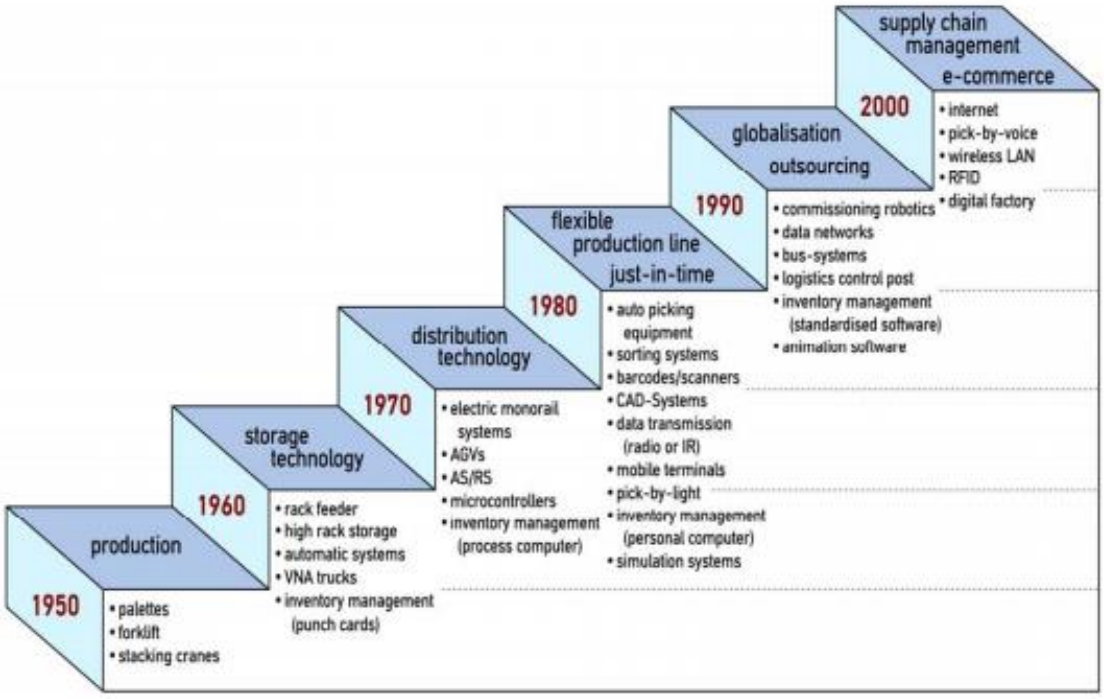

Figure 1. History of internal logistics. Adapted from *"Past, State-of-the-Art and Future of Intralogistics in Relation to Mega-trends",* by G. Kartning, B. Grösel, and N. Zrnic, 2012, *FME Transactions 40*(4), p. 193. Copyright 2012 by Georg Kartning, Faculty of Mechanical Engineering, Belgrade.

Kartning, Grösel, and Zrnic (2012, p. 196–200) argue that the most critical mega-trends that will have a significant impact on internal logistics are: globalization, urbanization, individualization, demographic change, climate change and environmental impacts, and ubiquitous intelligence, they relate mainly to reducing production costs and increasing the speed and use of advanced management, information and communication technology.

As stated by Fusko, Rakyta, and Manlig (2017, p. 214–215), Industry 4.0 represents a period of higher productivity, production growth and a 'pull' production system in which planning is subordinated to actual sales, while processes are based on customer demand. The interaction between machines and people will enable production systems to be up to 30% faster and 25% more efficient, and it also is estimated that Industry 4.0 will change production factories beyond recognition. The transformation will result in smart factories, where smart devices will takeover all manual and operational activities and organize efficient production operations together with control systems.

The interconnection of systems promoted by Industry 4.0, based mainly on the availability of real-time digital process information (e.g., the position of goods throughout the facility), has paved the way for the increasing acceptance of service robots into the logistics sector. In 2013, approximately 1,900 logistics systems were installed, which is 37% more than in 2012, which represented 9% of the total sales of robots for professional services. Approximately 1,300 automated guided vehicles in production environments generated a nearly 70% increase in sales for automated guided vehicles in 2012. The market for AGVs in manufacturing is expected to grow sharply in the coming years as essential preconditions for AGV investments are increasingly being met, such as:

- Digitization of factory floors. AGVs depend on digital data for their guidance and missions.
- Increasing the capacity and flexibility of fully autonomous navigation without the need to install markers or beacons.
- Improving energy storage technology (batteries, supercapacitors) increases the lifetime with shorter charging cycles.
- Increasing the positive reputation of AGV use, the ease of it throughout the manufacturing and logistics industry.

Between 2014 and 2017, more than 10,200 logistics systems will be sold, of which approximately 9,200 are AGVs. (IFR, 2019, p. 11).

The potential for the robotization of internal logistics is still vast. On the one hand, the growth of the logistics sector, reflected in the boom in e-commerce, requires the automation of more than just transport (i.e., AGV). On the other hand, advances in the perception, decision-making, and capabilities of robots technically make it possible to automate the handling and manipulation processes for a variety of objects. However, the advantages of using robotics to automate the handling of materials in internal logistics do not always justify the cost of a robotic solution. The need for efficient automatization of some manual internal logistics

processes remains unfulfilled. On the one hand, potential users, who are looking to automate some currently manual internal logistics processes, prefer to buy more flexible technologies, as the capacity of flexible systems can be utilized better in for a shorter payback period. On the other hand, technology providers would prefer to design their components in a way that would make them more flexible and can be used in different areas, with different products and processes, as some of their older technologies are struggling to find their way into the market or do not achieve enough sales to justify the costs of their development (Bonini et al. 2018, p. 380–381).

In 2018, Lakner and Winkler (as cited in Winkler & Zinsmeister, 2019, p. 538–539) reviewed the literature on current digital trends in intralogistics, and presented the results according to the number of references in various studies in Table 1 below.

Table 1. Identified internal logistics trends

Trend	Number of mentions in relevant literature
Self-organizing Conveyor Systems	
Automated Guided Vehicles	25
Camera-based Identification Systems	21
Augmented Reality	20
Active Localization indoor – outdoor	19
Collaborative Robotics	15
Smart Container Systems / RFID	14
Wearables	14
Automated Picking Systems / Pick-by-Robot	14
Machine Learning	13
Grid Sorter	12
Real-Time Simulation	11
Virtual Commissioning	11
Crowd-Logistics	11
3D-Shuttle Systems	9
Semantically enriched Data	8
Industrial Data Space	8
Predictive Maintenance	7
Crowd-Sorting	6
Drone Technology	4
Gamification/Employee Motivation	4
Shared-Service Business Models	4

Note: Identified internal logistics trends. Adapted from "Trends in digitalization of intralogistics and the critical success factors of its implementation" by H. Winkler and L. Zinsmeister, 2019, *Brazilian Journal of Operations & Production Management, 16*(3), p. 537-549.

From Table 1, we can see which trends are currently the most important for digitalization in intralogistics. Digitalization is currently one of the biggest intralogistics challenges for the industry. Let's look at the first three common ones: (1) Self-organizing Conveyor Systems, (2) Automated Guided Vehicles, and (3) Camera-based Identification Systems. From these areas, we can see a strong connection to the implementation of Industry 4.0 technologies, while among the most common trends is a strong connection with information technology, which is seen in the trends of (12) Real-Time Simulation, (13) Virtual Commissioning, and

(17) Industrial Data Space. The results of the frequency of trends shown in the table above, set the guidelines for the continuation of our study.

The research aims was to determine how the correct organization of internal logistics affects the success of the production process and what are some suitable approaches that would benefit internal logistics processes In doing so, we formulated two research questions, namely: what are the factors that are crucial for the optimization of internal logistics and in what way they affect the production environment of the company.

3 Method

Data collection was based on the analysis of articles from the last decade (2010–2020), with which we obtained an overview and the data for the research. The analysis is focused on identifying the factors that influence the proper organization of internal logistics and thus, successful production in organizations. There are many articles on the success of production processes in connection with the appropriate internal logistics, so we have limited ourselves to just a few of the latest ones, due to advances in the use of technology over the last decade. All articles were studied in detail so that we could summarize only the most essential data on the proper planning of internal logistics for successful. Most articles contained several factors that are repeated by different authors. The organization of internal logistics or the implementation of internal logistics processes affects the performance of production companies. The efficient implementation of internal logistics processes affects the implementation of efficient production, which leads to the success of manufacturing companies. We decided to explore which factors affect the efficient implementation of internal logistics and consequently, efficient production. After reviewing and collecting the results, we arranged them in a table to determine the key categories.

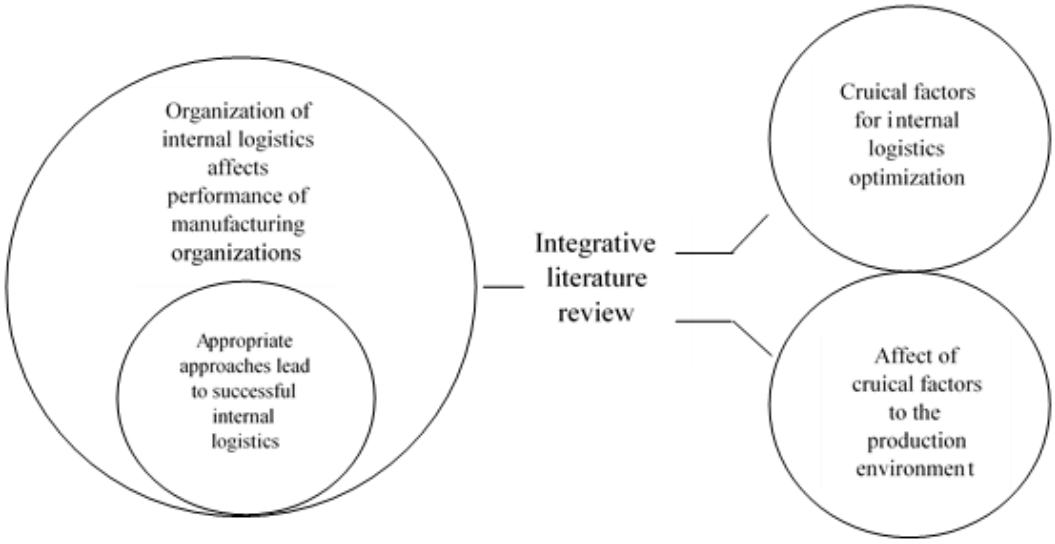

Figure 2. Research model

The research is based on an integrative review (Torraco, 2005, 2016) of the existing scholarly literature in the field of efficient performance based on an appropriate organization of internal logistics processes (see Figure 2). We used the method of a thematic analysis of the academic literature. The framework for the integrative part is based on the author Granlund (2011, p. 52), who notes that the question of the most important success factors for a well-functioning internal logistics system can be described by three areas: (1) performance factors such as delivery accuracy, inventory and delivery times, (2) information factors such as information systems, communication and information accuracy; and (3) flow-related factors and processes, such as good and balanced flow. The aspect of efficiency can be partially considered as a result of the system, but it also refers to internal capacity, as an example we can cite the accuracy of delivery for domestic transport, thus ensuring smooth operation. He also mentions a person as a factor of success, especially in terms of commitment and responsibility and the qualifications of people working in internal logistics systems. Similarly, Schulze and Wűllner (2006, p. 522) state that the internal logistics system with internal logistics activities is presented as a necessary and essential part for the entire operation of organizations in a wide range of operations. In the manufacturing industry, the main task of the internal logistics system is to provide the necessary stocks to the organization's operational units. Failure to flow materials or related information can lead to costly backlogs, which explains the importance of a well-functioning internal logistics system. Our research also led us to similar results. Based on the studied literature, an overview of key impact factors the organization of internal logistics, and thus, the performance of manufacturing organizations is presented. Using research databases (WoS, ScienceDirect, SpringerLink, Google Schoolar) we found articles that meet our requirements. The following inclusion criteria were set: publication of the article between 2010 and 2020 and the availability of the full text of the article in English. We reviewed all extracts of selected hits. In the revision, we included potentially relevant hits and selected those contributions that we used in the review. Articles were found by keywords, which are classified in Table 2. We did not find any original scientific papers in the Slovene language, or they were older than ten years, so we did not include them in the review. We found that many recent articles that would be suitable for our research appear were from various international conferences, and were published only in conference proceedings that have no impact factor, so we excluded them and did not use them in the research analysis.

Table 2. Keywords used in databases

Logistics
Interlogistics
Internal logistics
Manufacturing companies
Production performance
Efficient internal logistics
Modern technologies in internal logistics
Industry 4.0 in logistics processes

After reviewing the titles and abstracts of the articles, 215 articles met the criteria, 121 were excluded by reviewing the data (because they did not meet the inclusion criteria or were duplicates) and 84 due to inadequacies regarding the year of publication, so 10 articles were included in the final analysis. After identifying the topic, collecting, and reviewing the literature, evaluating the suitability and exclusions, selecting the appropriate articles, and identifying the categories, we came to the following findings.

The analysis of the articles showed that factors of internal logistics organization can be divided into three keygroups, namely: (1) the impact of information technology, (2) the use of lean production principles, and (3) the use of Industry 4.0 technologies in internal logistics. Different authors highlight the different factors shown in Table 3.

Table 3. Factors affecting the efficiency of internal logistics

Factor	Author	Impact Factor
1. Information technology	Fusko et al, 2017	0.784
	Jun et al, 2013	0.179
	Strandhagen et al, 2013	2.047
	Barreto et al, 2017	0.855
2. Application of lean production principles	Antunes, et al, 2013	0.283
	Reis et al, 2017	0.758
	Roessler et al, 2013	0.552
3. Industry 4.0 Technologies in Internal Logistics	Strandhagen et al, 2017	2.047
	Barreto et al, 2017	0.855
	Gregor et al, 2017	0.784
	Rocha, et al, 2010	0.552
	Vavrik et al, 2017	0.784
	Sun et al, 2010	1.342

4 Results

An integrative review of the literature showed that most authors emphasize the most important factor, the use of Industry 4.0 technologies in internal logistics processes, which is strongly related to the use of information technology, and both are strongly related to the third

factor, namely the use of lean production principles in internal logistics, especially in the field of efficient material storage and supply systems. The use of modern technologies of industry 4.0 in internal logistics enables the increase of the general competitiveness of organizations. Table 4 presents summaries of individual articles, with special emphasis on the different approaches of a successful organization of internal logistics.

Table 4. Presentation of key findings successful organization of internal logistics

Factor	Author	Key findings
1. Information technology	Fusko et al, 2017	**Reducing the cost of internal logistics** is one of the main ways to achieve a competitive advantage in the market. Traditional approaches to production systems need to be changed to digital. In the article, the authors present a new look at internal logistics with recommended **digitization** practices. The production process encompasses the activities required to convert the input string into results. The set of entries includes human resources, raw materials, components, equipment, energy, money, information, and so on. Market globalization, increasing global competition and more complex products require the use of new production and logistics technologies, methods and business processes. In the future, the production environment will require even more **urgent approaches to integrating information technology (IT)** into the production area. The article examines approaches for reducing costs of internal spare parts logistics by introducing new methods and technologies.
	Jun et al, 2013	**Building logistics computerization** is essential for the **development of manufacturing companies**. By choosing the appropriate method of building logistics computerization, a manufacturing company can save an investment provided that they meet their business requirements. The authors show **the essential ways of computerization of logistics** and explain **the method of building logistics computerization**, and then determine the suitability of individual methods of building logistics computerization for each of the types of companies, as divided in the article.
	Strandhagen et al, 2013	The era of Industry 4.0 is marked by rapid technological development and the need for manufacturing companies to become independent of labour costs. The use of 4.0 applications has been clearly outlined, but their relevance in different production environments is not clear. In this article, the authors identify and research **the industry 4.0 technologies** used in the internal logistics of manufacturing companies and the impact of production environments on their usability. As one of Industry 4.0's applications, they **also present a seamless flow of information**. The

		emphasis is on vertical integration for integrated information management, which can mean **improving internal logistics. The integration of IT systems and the digitization** of production in the context of internal logistics will mean that the tasks needed to direct the flow of materials through the factory are carried out with **the support of IT systems.**
	Barreto et al, 2017	Over the last decade, **the use and development of information and communication technologies in industry** has become completely unavoidable. The advent of the industrial Internet has spurred new challenges in **the field of logistics that require technological change**, such as the great need for transparency and control of the integrity of the right products at the right time, in the right place, the right quantity and at the right cost.
2. Application of lean production principles	Antunes, et al, 2013	Based on a case study of the supply of components on the assembly line of car audio systems, the authors recognize that the **Six Sigma methodology, combined with the principles of lean manufacturing**, represents great potential in **improving internal logistics processes**. The use of continuous improvement methodologies such as Six Sigma and lean principles in the field of internal logistics are key concepts of the article. Variables indicating the quality and performance of internal logistics are grouped into three categories: delivery delays, supply errors and delivery errors. The result of the study is reflected in the proposed improvements to **reduce errors** in the procedures of supply of assembly lines with the necessary components. The lean logistics and Six Sigma methodology are presented as key factors to **reduce non-value added activities and improve the organization's internal logistics.**
	Reis et al, 2017	Managing the internal logistics process is an issue that has currently become crucial to success in a competitive market within any industry and supply chain. Based on an empirical study of **the principles of leanness in the storage** of oil and gas companies, the authors show the importance of **applying the principles of leanness in the production context, especially in the storage industry**. The industrial environment often underestimates internal logistics, which may be due to the fact that it does not create added value. Internal logistics processes in terms of internal storage and material handling often remain intact in terms of improvements. The article offers **solutions in terms of lean techniques in the field of internal logistics operations.**

	Roessler et al, 2013	To manage the growing complexity in **the design of lean machine-internal logistics systems**, a process model is needed to systematize the space for solutions. The authors state that in **the material flow planning phase of lean manufacturing,** key performance indicators for design alternatives, taking into account machine tools and elements of intralogistics, are obtained through simulation. In the case study, three possibilities of designing machine-internal logistics systems were evaluated, taking into account five key performance indicators. **A relative lean corridor can be determined** for each design variant. This paper sees a special emphasis on tool and internal logistics configurations to achieve **optimization and proper planning.**
3. Industry 4.0 Technologies in Internal Logistics	Strandhagen et al, 2017	The era of Industry 4.0 is marked by rapid technological development and the need for manufacturing companies to become independent of labour costs. **The use of 4.0 applications** has been clearly outlined, but their relevance in different production environments is not clear. In this article, the authors identify and research the impacts of **Industry 4.0 technologies used in the internal logistics of manufacturing companies** and the impact of production environments on their usability. Multiple case studies have been conducted and the findings show that the applicability of Industry 4.0 in production logistics depends on the production environment. **Companies with a low recurrence rate see less potential in using 4.0 technology in internal logistics, while companies with very recurring production see more potential.**
	Barreto et al, 2017	In addition to the already mentioned emphasis on the use of information and communication technologies, the authors present other findings on important dimensions that are necessary for the full implementation of **the logistics paradigm 4.0.** Under the requirements of Industry 4.0, Logistics 4.0 also includes a range of **technical components, software and human support.** Logistics 4.0 can be interpreted as optimized logistics systems **designed by a high degree of automation.**
	Gregor et al, 2017	Rapid development not only changes products and their functionality, but also brings a new perspective on the monitoring, control and optimization of logistics activities. The authors present the described changes in the case of a selected company, where a large number of manual operations performed by employees are transformed into an automated, flexible and intelligent form. Smart Connected Logistics concept is highlighted, which brings a significant increase in efficiency. The results are shown as **savings in**

		the use of mobile robotic systems compared to human labour. They find 89-90% cost savings, while also 20-30% performance growth and a significant reduction in errors. Autonomous intelligent solutions represent the future of logistics, both with updated equipment and a changed logistics concept.
	Rocha, et al, 2010	The authors of the article **emphasize the use of automated guided vehicles in material handling systems** and flexible production systems, where production orders are constantly changing. They enable **a significant reduction in time consumption, increase the flexibility of the production process,** which in many production processes still lags behind expectations due to inadequate transport systems. In the case of simulation, the article examines the impact of the use of automated guided vehicles in a selected company, and the result is reflected in **higher system productivity.**
	Vavrik et al, 2017	The article describes the results of the research project, and at the same time presents the method of determining the number of automated guided vehicles and the selection of the optimal internal logistics route of the company. **New technologies are significantly changing internal logistics,** so **internal logistics is gradually becoming more flexible**, which requires changes to the overall concept of future solutions. The research examines **the automated logistics system** of the planned operation of the production of semi-finished products within the process of production of components in the automotive industry. A simulation model of the logistics system is proposed, which contains the required number of automated guided vehicles and vehicle track optimization.
	Sun et al, 2010	Although, an extremely **high level of automation** is achieved within logistics and in production today, human labour is still used for transport by trolleys and forklifts, resulting in high labour costs and a risk of damage. Fixed-mounted conveyors are used in automated warehouses, but they are not flexible in the event that the company's production lines change. As a solution, the article presents a new approach with **a composite group of autonomous robots that perform tasks within logistics.**

We found that the key factors influencing the successful implementation of internal logistics processes are (1) the use of information technology, (2) the use of Industry 4.0 technologies in internal logistics processes and (3) the use of lean manufacturing principles in internal logistics. The text below describes how different authors connect them with the successful organization of internal logistics and also with the success of production organizations.

Information Technology: Fusko (2017, pp. 214–215) says that information and communication systems are on the one hand very well developed, and on the other hand many factories are still not ready to transform from classic technical services to digital technologies. Appropriate information technology in the field of internal logistics reduces the amount of work, which in itself does not bring added value (search in the warehouse, ambiguous labelling, surpluses and shortages of stock in the warehouse, on production lines…). However, the introduction of information systems means significant cost reduction in internal logistics processes. He also states that globalization of the market, increasing global competition and the complexity of modern products necessitate the use of new production and logistics technologies in business processes. The production environment requires the integration of information technologies into its area, both in terms of applications in the right equipment and new methods and technologies that need to be integrated into internal logistics (Fusko, 2017, p. 218). Similarly, Jun et al. (2013, p. 5), state that in the logistics process of manufacturing companies, the use of information has become a key factor in increasing operational efficiency, reducing costs, and improving the quality of customer service.

Industry Technologies 4.0: Strandhagen et al. (2017, p. 344–358) say that automation and the use of robots are important not only in production processes, but also for transportation, the supply of production lines, and handling of materials within companies. AGVs are just one example of material transport systems in manufacturing companies, which from the point of view of autonomy represents an important industry 4.0 system. Technological development, autonomous and automatic systems for transport and handling of materials greatly benefit the organization’s internal logistics, and in order to achieve efficient internal logistics, in addition to improving the flow of materials, emphasizes greater use of information technology and control over reducing stocks of raw materials and finished products. Barreto et al (2017, p. 1248) present smart logistics as a logistics system that can increase flexibility, adapt more easily to market changes and bring customers closer to customer needs, based on improved customer service, production optimization and lower costs of storage and production processes. All this is possible only with the use of the latest technologies in the Industry 4.0 period. Also Rocha et al. (2010, p. 248–255) claims that more and more internal logistics processes should be fully aligned with production resources (machines, tools, and operators) and thus support complexity. Internal logistics systems depend on the type of production, the type and quantity of products produced, as well as on customer requirements (production processes where work is done in stock or according to customer orders). He notes that by improving internal logistics processes, we are influencing more efficient distribution and production flows, citing conveyors, automatically controlled

and similar vehicles as solutions, which provide flexibility, reliability, lower labour costs and higher productivity in connection with the development of technology to manage these vehicles. Similarly, Vavrík et al. (2017, p. 923–928) believe that new technologies are changing internal logistics, citing as an example an automated logistics system of production operation with an optimized supply of materials using an appropriate number and appropriate models of automated guided vehicles.

Application of lean production principles: Antunes et al. (2013, p. 414–419) claim that the approach of using Six Sigma in combination with the concepts of lean production represents a great potential that can be successfully used in improving internal logistics processes. Similarly, Reis et al. (2017, p. 342) note that internal logistics management is an issue that has become crucial to success in a competitive market of any industry, emphasizing the application of lean production concepts in manufacturing companies, especially in warehousing. Similarly, Roessler (2013, p. 559–564) presents the use of lean production concepts, which emphasizes the connection between material flows and internal logistics elements for material handling and the development of concepts for appropriate internal logistics solutions and integration into lean material flows.

The automation of individual internal logistics processes should be emphasized. The benefits of automation are great, especially in internal logistics due to the often large amount of repetitive manual work. As an example, Frazelle (2012, p. 22) presented a methodology for the design and transformation of storage systems, where automation is also listed as one of the common denominators of successful warehouse operations. Automation includes computerization and mechanization, where mechanization refers primarily to the automation of the physical flow of goods, and computerization to the flow of information. The level of automation is a concept often used in the discussion of the development of automation. It is often used in assessing the level of automation. The level of automation can be described as a variable that ranges between fully manual and fully automatic control (Frohm, 2008, p. 12–13).

Highly automated product manufacturing is an important way to achieve industry competitiveness, especially in parts of the world where labour costs are relatively high (U.S. and Europe). The development in the 20th century is mainly in the direction of automating the production processes of manufacturing companies and thus increasing efficiency and quality in production. A higher level of automation includes not only the actual manufacturing processes, but also higher automation of support tasks (material handling, transport, and storage). In the 1980s, the emphasis was on full automation in all production units, but systems in manufacturing companies remained semi-automatic, consisting of a combination of automatic and manual tasks. Product customization requirements have increased, production systems have become increasingly complex, but automation has not necessarily led to higher efficiency. As an integral part of the production system, it is also necessary to include a person who must be involved in technical progress and must be qualified to operate machinery and equipment. From this, we can conclude that just like automation and the use of

advanced technologies, efficient production requires an appropriately qualified workforce (Frohm, 2008, p. 2–3).

5 Discussion

Production processes and the technology used have changed dramatically in the last fifty years. Automation has mostly replaced manual process management, which represents a sudden leap for production in terms of both productivity, accuracy and further competitiveness and performance. Despite these facts, the processes of internal logistics, which decisively support production, in many cases still lag behind the development of production itself. Procedures for receiving, storing, and transporting of materials and delivering them to the various production stages remain unchanged, while companies still do not decide to upgrade and continue to use outdated systems. This is partly due to the rapid automation of production. All available resources and assets have been invested in it by production companies in an essential production process, while internal logistics processes have lagged. As another factor for stagnation, we can also consider that until recently, solutions to improve internal logistics processes were often very expensive and inflexible, which is a considerable problem for manufacturing companies. The introduction of changes in terms of modern technologies in internal logistics processes was a risky and challenging investment from a business point of view. Production internal logistics procedures are very inefficient if they are not technically perfect. Production companies with such an unfinished internal logistics system are losing control over the efficient management and control of supplies, which is the basis for successful production processes. For this reason, there is a more significant investment in production equipment and workers who take care of supplies.

The analysis of the articles shows that the success of production companies can be achieved through different approaches to the design of internal logistics processes. The most important is the use of Industry 4.0 modern technologies in the planning of internal logistics processes, which in connection with the transformation of processes from semi-automatic to fully automatic and in close connection with appropriate information technology, significantly contributes to the success of not only the production process but the overall competitiveness. Modern technologies need to be introduced into individual internal logistics processes and thus achieve higher performance, which, in combination with appropriate information technology and lean production concepts, bring critical competitive advantages to manufacturing companies.

Granlund (2011, p. 2–3) points out that the benefits of using automation in internal logistics activities (internal transport, material management) are excellent, as they are often characterized by a large amount of manual work, both time-consuming and physically strenuous. Logistics costs vary according to the degree of automation in logistics processes, and higher automation can also have other advantages, such as increased capacity and improvements in the work environment. Automation is probably a key point in the development and optimization of internal logistics.

A significant factor is the automation of internal logistics processes with the introduction of Industry 4.0 technologies, which answers the research questions that the appropriate organization of internal logistics processes affects the performance of manufacturing companies. Automation is an effective way to achieve the success of manufacturing organizations, also in conjunction with the transformation of internal logistics processes. At the same time, a person is a palliative for difficult and dangerous tasks, but we must not forget that it also has its drawbacks. The company must prepare adequately for the introduction of automation of internal logistics processes, as there may be incompatibilities if organizations do not prepare for automated internal logistics procedures in advance with the correct distribution of functions and tasks between man and automated equipment.

Based on a review of the literature, we can confirm the impact of adequately organized internal logistics on the performance of production processes and thus the competitiveness of manufacturing companies. The internal logistics system includes all activities related to the management of the flow of materials within the organization. We believe that, as a system, it represents an important part that needs to be continuously improved. Automation is a tool that has great potential for improving internal logistics. Despite the high potential and the growing trend of use, automation in the field of internal logistics processes is still not used as often as in other phases of production processes. The use of technology such as automation, therefore, affects competitive advantage and can worsen or improve an organization's competitive position, so it is imperative that it is appropriately used to ensure a positive effect. To achieve this, it is necessary to find both the level and the type of automation that best suits the needs and requirements of the environment in which the automated equipment will be used.

6 Conclusion

With the Industry 4.0, internal logistics in manufacturing companies represents a new dimension. Internal logistics in production contributes to better movement management and inventory control between different production processes, technology, modern software, and automation represent a positive factor needed for optimization. Automation of internal logistics processes creates a competitive advantage by reducing costs, increasing flow, and responding more quickly to changes in demand. Optimization of internal logistics for production companies represents greater efficiency of individual processes, and it is crucial that the company before investing in advanced technologies in terms of automation of internal logistics, assesses the state of the processes and develops a strategy for successful implementation of automation.

The article provided an integrative review of the literature on effective organization of internal logistics processes that shape the performance of manufacturing organizations. By taking into account, the key factors of the optimization of internal logistics, both top management and management of individual production departments can plan more appropriate, efficiently, and more rational internal logistics processes in manufacturing organizations, thus, affecting overall competitiveness. The identified key factors can lead to

critical decisions or at least specific guidelines that can be used by any manufacturing organization in planning of internal logistics processes. The changed processes of internal logistics in production affect and shape the performance of production companies. Many manufacturing organizations still have difficulties in finding and selecting appropriate automation of their internal logistics processes, which can be a starting point for further research. Problems arise mainly due to poor insight into the current state of efficiency of internal logistics, lack of strategic view of internal logistics, which leads to incorrect assessment and decision-making regarding the development of automation. Also, the three factors that influence the organization of internal logistics processes highlighted in the article represent only a part of possible improvements and are indeed subject to further research.

The research is limited both in terms of the number of contributions and the broadness of the topic. For more detailed results, it could be expanded and adapted to different types of manufacturing companies, which would further improve the insight into the key factors for the success of internal logistics processes.

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Povzetek:
Vpliv notranje logistike na uspešnost proizvodnih podjetij – pregledni članek

Raziskovalno vprašanje (RV): Kakšen je vpliv kakovostnega izvajanja notranjih logističnih procesov na uspešnost proizvodnje?
Namen: Ugotavljamo kakšen način organizacije notranje logistike je najprimernejši za uspešnost proizvodnega procesa ter s katerimi pristopi izboljšujemo kakovost organizacije notranjih logističnih procesov.
Metoda: Rezultate bomo iskali s pomočjo pregleda člankov in že obstoječe literature iz obdobja preteklih nekaj let. Osredotočili se bomo na novejšo literaturo, saj se pregledni članek navezuje na spremembe, ki so se začele v obdobju industrije 4.0.
Rezultati: Organiziranost in vlaganje v procese notranje logistike v proizvodnji vpliva na kakovost opravljanja proizvodnje in s tem tudi na konkurenčnost podjetij. Z rezultati želimo prikazati možnosti, s katerimi pripomoremo k izboljšanju procesov notranje logistike.
Organizacija: Prikazani rezultati lahko pripomorejo k sprejemanju pravilnih odločitev pri organizaciji logističnih procesov znotraj proizvodnje ter k pravilnejšim vložkom s strani vodstva v izboljšave in napredne tehnologije za izvajanje logističnih procesov.
Družba: Nižji stroški, ki jih prinaša pravilna organiziranost notranje logistike v proizvodnji predstavlja za organizacijo veliko konkurenčno prednost, hkrati pa z implementacijo naprednih tehnologij razbremenimo tudi delavce.
Originalnost: Celovit pregled obstoječe novejše literature o vplivu pravilnega načrtovanja, organizacije in načina izvajanja notranje logistike na uspešnost proizvodnje v podjetjih.
Omejitve/nadaljnje raziskovanje: Analiza bo še vedno omejena zaradi omejenega števila literature in člankov.

Ključne besede: notranja logistika, proizvodnja, uspešnost, izboljšave, tehnologija.