TRENDS IN THE USE OF INFORMATION TECHNOLOGY IN LOGISTICS SYSTEMS MANAGEMENT

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Abstract

There are more and more modern logistics systems on the market that, as part of control systems, must guarantee production flexibility, required delivery dates, market readiness and liability for binding capital into inventory. Market globalization imposes the necessity of meeting certain standards in business that guarantee the quality of work done. The rapid development and use of information and communication technologies in support of the individual needs of users are becoming increasingly important for successful implementation of business activities. The paper analyzes the role of information and communication technologies in logistic processes and in the integration of logistics systems. Examples from practice confirm the reasons for increased investments made by companies engaged in this segment of work with an aim to optimize business operations and increase profits. The emphasis is placed on the significant role of information technology in logistics operations, current results and applications, as well as possible future applications.

Keywords: Information technology, management, logistics systems, logistics processes, optimization

1. Introduction

Logistics is an integral part of our daily lives. It has a greater role and more influence than most other human activities. Logistics also involves well-known supply chain management. It includes not only physical production but also service activities (Brčić, Ševrović, 2012: 2). Its purpose is to continuously improve the flow of goods and information through the enterprise, reduce inventory, and shorten production lead time at the lowest cost.

An increase in the level of competitiveness and technological progress in the early 21st century has resulted in new approaches to the optimization in this activity as it implies high costs if the final result to be achieved is to provide a high level of customer service.

In their paper, Renko and Fičko (2009: 157) list the elements of a logistics system, such as order and delivery, warehousing, inventory management, handling (manipulation), transportation (outdoor and indoor) and logistics information system and stress that these elements are closely related and that every logistics process begins with the procurement of raw materials, which are then transported through

the production process to finally reach the customer as a finished product.

Logistics is embedded in all other functions of a company (procurement, production, distribution, storage). The tasks of logistics inside these functions overlap in their daily operations. In such a way, the tasks of procurement logistics refer to the management of the flow of goods, the choice of a warehouse location and type, packaging-related tasks, the use of a certain mode of transport, the use of additional transport resources, quality control, inventory management and the management of loading, reloading and discharge.

Production logistics is part of micro-logistics that deals with the internal flow of materials to the production site and at the production site. The main goal of logistics is to provide the production site with the right materials in the required quantity, at the right time and at the lowest possible cost. Its tasks include the decision on whether a product is going to be produced in one's own production facilities or acquired from a supplier, the structuring of production according to logistics aspects, production planning and control as well as the shaping of the physical flow of products and information on the products throughout the production process. The tasks of distribution logistics refer to the control and reception of finished products, storage of finished products, shipping and transportation of finished products and the disposal of excess and damaged materials.

The task of warehouse logistics is to solve questions about the necessity of storage, the function of storage, optimal storage, optimal storage systems and most economical means of transportation. Since storage costs are often high in relation to the total costs of the company, of particular importance is storage optimization, i.e. optimization of processes required to transport goods to a warehouse in the most cost-effective way, arrange them properly and deliver them to end-users.

In daily operations, it is extremely important to connect all the elements of the logistics system and provide a high-quality, fast and accurate flow of information. Information and communication technologies enable the implementation of these tasks.

The hypotheses of the paper are: the global transport and logistics sector is faced with the transformation of business deriving from the way in which new digital technologies, changing customer expectations and collaborative business models impact the market; there is an increasing demand for integrated logistics services aimed at improving the quality of work and reducing costs, so that logistics companies have been developing based upon the principle of the central distribution warehousing system; the development of intermodal transport is a prerequisite for sustainable development and meeting the requirements of modern lifestyle (safety, ecology, time efficiency).

To fulfill the aforementioned objectives, investments in the development and use of ICT infrastructure are necessary, as well as automation of business logistics processes.

Even though many companies have perceived the importance of the fast progress of technology, they cannot keep up with it, at least not in the way required by the ideal image of scientific and professional knowledge in this area.

The motive for writing this paper is to highlight the current trends applied in practice, but also to point out possible improvements.

2. Research Methodology

Information in electronic form is a factor without which no segment of a competitive modern business today can operate or be planned.

Every day questions arise as to how to accept this kind of information, how to develop it and how to achieve competitiveness in today's market by using it. Technology promotes a new way of thinking and behavior of people while carrying out business activities. It also develops innovative forms of management that use technology in management-related activities, and point to the need to improve its implementation in business practice. The primary and the secondary purpose of using technology are to increase the efficiency of human labor and communications, and to increase profits as a result of enhancing the aforementioned primary parameters, respectively.

The segments of E-commerce in a business system are becoming more sophisticated and more numerous. This paper analyzes the importance of the IT system and the application of information technology in modern businesses whose core business is logistics and logistics systems. Special attention is given to the description of computer and information technologies and their integration into logistics

systems. The examples from companies illustrate the development of the logistics market in the Republic of Croatia and the importance of development and the role of information technology in logistics companies with the purpose of optimizing work and increasing profits.

Research related to this paper was preceded by a comprehensive interdisciplinary research study, the result of which was a final paper written by a computer science undergraduate student and defended at Josip Juraj Strossmayer University of Osijek, Faculty of Electrical Engineering, Computer Science and Information Technology Osijek. The paper was entitled "Application of information technology in logistics systems in the Republic of Croatia" and its goal was to look at the past and present, but also to build projections for the future implementation of information technology in logistics operations.

Research presented in this paper mainly uses secondary sources of information and knowledge. It explains the importance of information technology in supporting logistics processes as well as the importance of information technology in the integration of logistics processes, and highlights trends in using advanced technologies in logistics processes. An analysis of improvement in the operation of several companies based in the Republic of Croatia as a result of investments in information and communication technologies points to the benefits provided in the daily logistics operations. Methods of deduction, induction, analysis, synthesis, descriptive modeling, causal reasoning, historical method, methods of generalization, specialization, composition, analogy, classification method, and other scientific methods are used in this research.

3. Information technologies as support to logistics processes

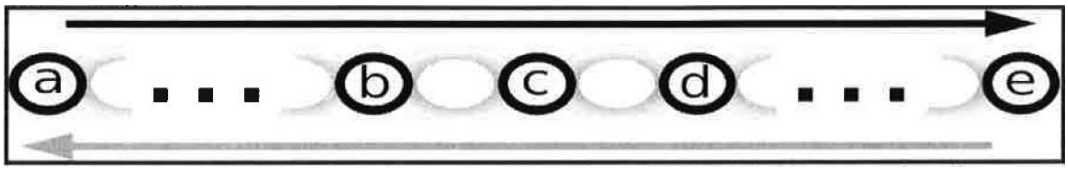
Modern business imposes the use of the process approach which entails daily use of information technology. This primarily refers to the development of a customer oriented business process model.

A set of interconnected logistics processes makes the logistics chain that involves a flow of information in both directions. It usually consists of an inventory management process, a procurement process, a storage process, a transportation process and a return process (Jujnović, 2011: 295).

The logistics chain that consists of a series of processes, sub-processes and activities that are interrelated is shown in Figure 1.

- → material and information flow,
- ← information flow,
- a – information flow and feedback,
- b – an initial supplier (raw materials),
- c – a supplier,
- d – a manufacturer,
- e – a consumer or an end user.

Figure 1 Logistics chain

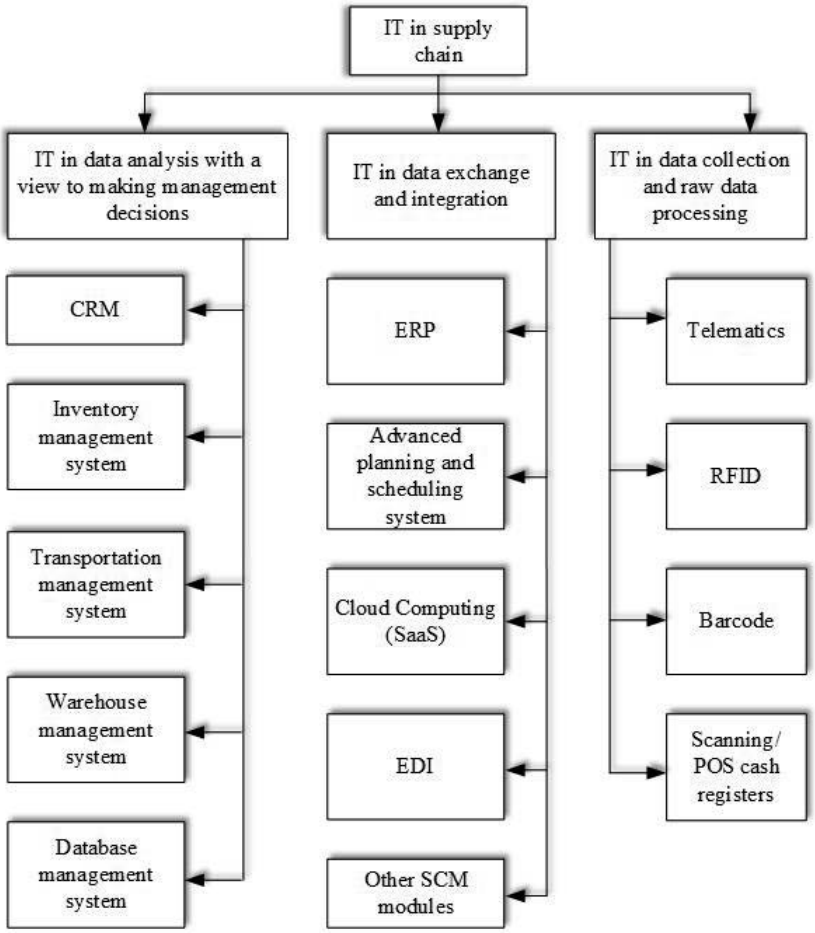


Source: Jujnović, 2011: 295

It also shows the impact of the flow of information in the integration of logistics processes, and the importance of an interdisciplinary approach of information technology, organization and economy to the logistics chain in order to improve the quality of communication, accelerate feedback, create a better environment for product differentiation with the lowest costs possible.

Classification of the most frequently used information technologies in the supply chain in terms of the complexity and their respective purposes can be seen in Figure 2.

Figure 2 Information technologies in the supply chain



Source: Created by authors according to Dujak et al., 2011: 262

By analyzing the logistics processes and the application of information technology in certain segments we can make a synthesis as follows.

It is known that too much inventory incurs high inventory holding costs, and too little inventory leads to a number of problems and negative consequences for the production, trade and distribution. Consequently, it is necessary to determine the optimal order quantity and the optimal ordering time.

The intensive organized use of information and communication technologies by the participants in the logistics chain e.g. advanced applications that are used to calculate input and output inventories, enables us to gather all information needed to make the right decisions about the level and type of inventory. In this way, we may reduce the costs of storing excess inventory, the costs of administrative errors and the costs related to non-fulfillment of order due to lack of inventory.

The set of processes and activities relating to physical inventory management makes the process of warehousing (finished goods, intermediate goods and raw materials). The purpose of using computer technology is to improve the coordination of goods from the moment of their entry into the warehouse to the moment of their exit from the warehouse, and it refers to everything related to the collection, storage and distribution of data and information

depending on the organization of warehouse operations in a company that is often conditioned by the type of economic activity.

In order to increase efficiency and ensure a competitive advantage of a company, irregularities that may occur, such as insufficient use of storage space, inefficient use of manpower, slow flow of goods, lack of information on the quantity of goods stored in the warehouse and the time of storing, item replacement, but also the inability to find a specific item in the warehouse, should be minimized. Systematic warehouse management through the so-called WMS (Warehouse Management System) plays an important role in the process of storage. It represents a solution to monitoring and control of all warehouse processes without a paper trail, and its function in the daily work is to support and facilitate the movement of goods in the warehouse (reception, putting goods in the appropriate place, selection of items upon the reception of order, and delivery).

The use of information and communication technologies in the procurement process increases the quality of relationship and the level of cooperation between customers and suppliers as they obtain the necessary information needed to make the right decisions in a timely manner. The use of electronic procurement (also known as e-procurement) contributes to streamlining the procurement process, its improvement, a more rational use of resources, and greater competitiveness on the market.

Much research has been focused on the distribution of materials or products since despite technological advancements and good cooperation between business partners only a small number of companies manages to reduce transportation costs. Delivery route planning, vehicle tracking, driver monitoring, and vehicle maintenance are just some of the activities that companies supported by information and communication technologies do for the purpose of improving and optimizing the transport chain.

Mobility technology plays an essential role not only in achieving a synergistic effect of various modes of transportation - land (road, rail and pipelines), water (shipping), and air, but also in increasing the efficiency of company vehicles and employees. This implies the concept of telematics which includes telecommunications, automation and information technology, whose synchronized action enables the application of intelligent transport systems (pre-trip information and on-trip driver information, traffic management, driver support, traffic management and control, shipment tracking, fleet management, security, etc.).

Devices and technologies that perform fundamental telematics functions in traffic are detectors, sensors, video, radars, RF technology, GPS and GSM technologies, and intelligent transport systems applications adapted to individual transport branches.[1]

Telematics enables the exchange of information between all vehicles and the central system. For example, one or more devices are fitted into vehicles to record and collect information from the vehicle. One of the devices is used for communication between the driver and the central system, thus making it possible for the driver to transmit data to the central system without having to make a stop. Controlling can be raised to a higher level at lower cost because the technology enables us to determine the location of each vehicle, and monitor the operation of its engine, its speed on the road, the need for service, as well as the level of humidity and temperature, which is particularly important for transportation of sensitive goods. In the event of an accident, necessary information about the accident can be gathered quickly and effectively, such as the location and cause.

Telematics provides a high degree of safety when very expensive or sensitive cargo is transported. It also enables traceability of goods to both customers and suppliers.

Ensuring transparency in the logistics process results in considerable savings (reduction of vehicle maintenance costs, fuel consumption, and the number of employees managing the required documentation and implementation of controlling), speeds up delivery time, and reduces the number of accidents by close monitoring of drivers.

No less important part of the logistics process is the process of return of goods, which can be explained as reverse flow of goods through the distribution logistics chain. The basic function of information technology in that chain is to record requests and provide reasons for the return of goods to facilitate the procedure of return, but also to manage the amount of returned goods.

The necessity of interaction among several companies in this segment of the logistics process implies complex IT systems, and accordingly a small num-

ber of companies have a successfully automated IT environment of the return process.

Computerization of the return process is ensured by a set of EDI standards (Electronic Data Interchange), whose purpose is the electronic transfer of structured data from one computer application to another. Precision and accuracy of the work done thus become greater as the possibility of human error in this kind of work is minimized since documents such as purchase orders, delivery notes, invoices, payment notifications and the like are exchanged electronically.

This approach to work raises the standard of the return process and represents a significant step in its development.

4. Information technology and the integration of logistics processes

In order to enhance the efficiency of a company, companies increasingly recognize the importance of cohesion and coherence of logistics processes. Today, information and communication technologies are playing a key role in this segment through the exchange of information, joint planning, coordination of business activities and the acceptance of new business models and technologies, which can be seen from Table 1.

Table 1 Integration of the logistics chain across four areas

The exchange of information among members of the logistics system enables us to: • reduce the impact of uncontrolled "rampage", • detect problems earlier, • respond faster, • build trust and confidence.
Joint planning, monitoring, updating and design enable us to: • reduce costs (non-manufacturing overhead costs, operating costs), • reach higher capacity utilization, • provide a higher level of customer service.
Coordinated workflow and operations enable: • more efficient logistics services, • faster response to client requests, • improved services, • convergence of services in the market.
Acceptance of new business models and technologies enables us to: • enter new markets, • offer new services, • improve efficiency, • embrace mass customization.

Source: Jujnović, 2011: 301

Barcode technology, electronic data interchange (EDI), and RFID (Radio Frequency IDentification) technology that uses radio waves to automatically identify people or objects are especially important in the aforementioned business activities.

4.1 Barcode technology

After the long historical development of this technology, the EAN system was created in 1976 as a result of striving for standardization and it represents the European product labeling system. The EAN-13 barcode is mostly used in Europe for labeling individual products (or their packaging). The first two digits indicate the country of origin (in which the product was packaged), the next four reveal the manufacturer, and the next six refer to the product itself. The last digit is used for verifying the authenticity and it is called the check digit (Mesarić, Dujak, 2009: 121).

As of 2003, logistic labels with the SSCC code (or the Serial Shipping Container Code) have been used, i.e., an 18-digit numerical data structure as the key to providing information on the logistic unit composed of a number of different products.[2] Its purpose is simplified loading, shipment routing, and automated reception of such logistic units.

Such codes have made the flow of goods and information faster and more extensive, and improved business operations in terms of production, transport, trade, and other services.

The codes consisting of a series of printed columns or bars of varying thickness which are used to store certain data reduce the possibility of human error. Codes given on logistics labels placed on logistic units are read by means of RFID technology, which then allows you to store data electronically. Such data storage is faster and more accurate than typing in the product key.

Barcode technology relies on a system of encoding data that is optically read later in the process and converted into digital data by using a scanner and a decoder.

4.2 RFID technology

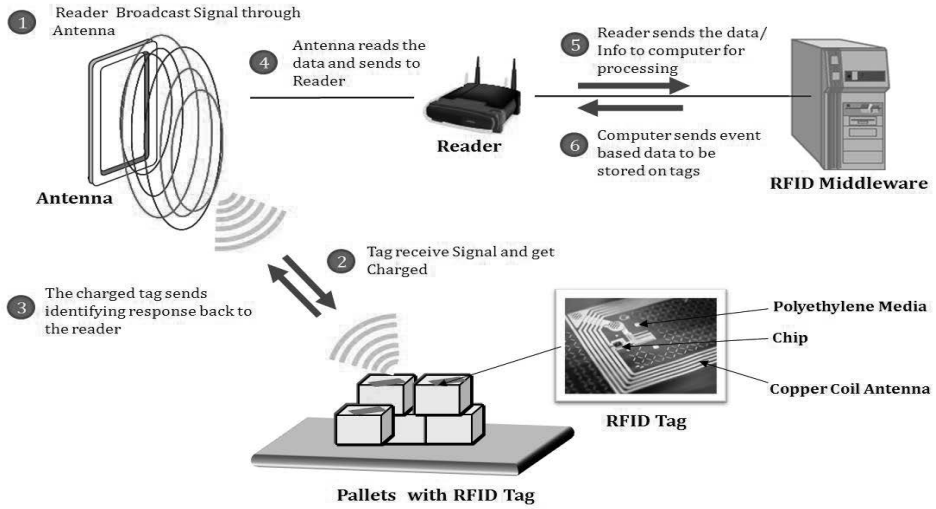
One of the most effective forms of radio frequency technology is RFID technology which is classified as an automatic identification technology, such as barcode, a chip card and biometric technology (Dujak et al., 2011: 263).

This is a technology in which logistic units are identified by using electromagnetic waves in radio frequency bands, the main benefits of which are the contactless prompts (the term *tags* is used in everyday practice) containing information with the possibility of entering additional new information.

Readers can quickly identify a large number of tags (more than 100 per second). A small integrated circuit (chip) and an RF antenna form a tag. If there are batteries therein, these are active tags; without batteries, we deal with passive tags. There are several different forms of RFID transponders: tags, labels, cards, etc.

An RFID system consists of the following components: an RFID transponder, an RFID reader and an RFID antenna. Most RFID transponders we use today do not have their own energy supply (as they do not have a built-in battery, they are referred to as passive transponders), but receive it through radio waves such that the reader comes into contact via its RFID antenna that emits radio waves into space around it. When the transponder is close enough to the antenna, it receives radio waves providing enough energy for operation. This allows it to establish communication with the reader under the set protocol, under which the desired information is exchanged. Their communication range varies from 5 millimeters to 5 meters. Their storage capacity is relatively small. They are used to identify products that enter, leave or move around the plant. In some RFID systems, we use transponders with built-in batteries (with a service life of 5-10 years). Such transponder is said to be active. In such systems, transponders do not consume energy for their operation from the electromagnetic field emitted by the reader, as it is provided by the battery, so for this reason, the field may be weaker or the communication distance between the transponder and the reader is greater. This provides a greater range of reading data. Their storage capacity and the strength of the radio frequency signal are much higher, and they are often used in situations when you need to locate an object. They are also more expensive than passive transponders. In addition to transponders and readers, this equipment also covers smart tag printers. Their purpose is to add a barcode and enter the desired content in the RFID label.[3] The aforementioned is shown in Figure 3.

Figure 3 RFID system



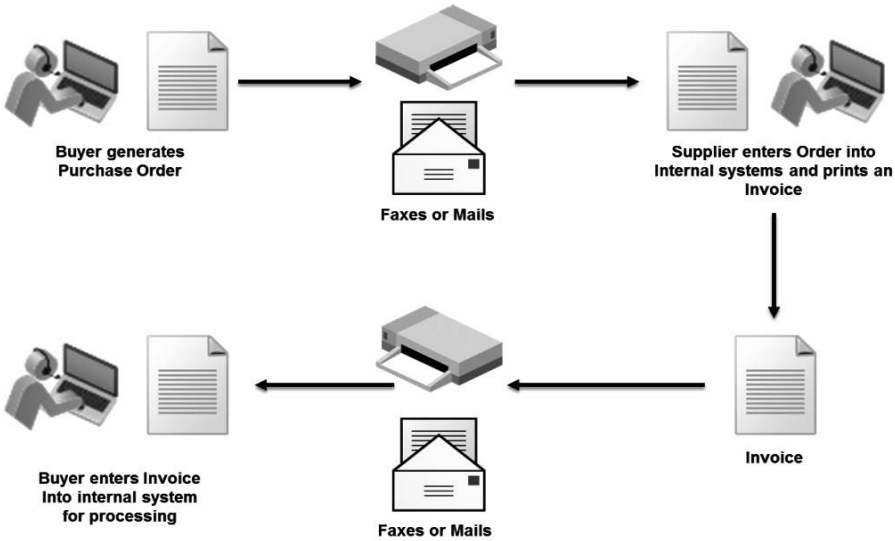
Source: Crnjac Milić et al., 2015: 287

RFID technology promotes the efficiency of internal work processes, ensures accuracy, gives a better insight into the processes and enables inventory reduction.

4.3 Electronic Data Interchange (EDI)

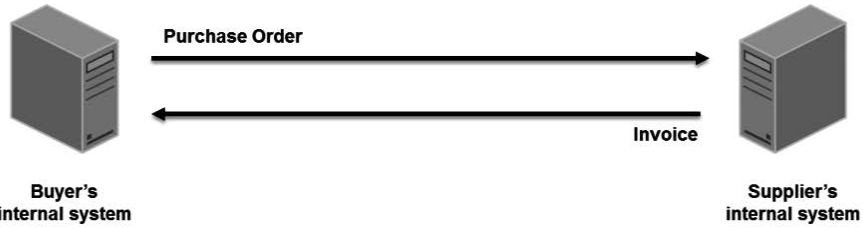
EDI (Electronic Data Interchange) is defined as the transfer of structured data, by agreed message standards, from one computer system to another without human intervention.[4]

Figure 4 Manual data exchange process



Source: EDI Basics, "What is EDI (Electronic Data Interchange)?"[5]

Figure 5 The EDI process



Source: EDI Basics, "What is EDI (Electronic Data Interchange)?"[6]

Figure 4 and Figure 5 indicate the purpose of these systems in their daily operations, i.e., to achieve greater efficiency and cost reduction due to accurate and timely transfer of documents without paperwork. It facilitates communication between business entities and standardization of business operations.

In logistics processes, EDI technology is particularly important when an organization links its information systems to those of its suppliers, searches their databases, orders items electronically, chooses the best offer, has current information at its disposal and transfers standardized documentation (Andrlić, Hak, 2008: 155).

5. *Trends in logistics processes*

Outsourcing has become a popular trend and an important business strategy for boosting operational efficiency, espeacially as part of modern logistics.

Decisions on the type of outsourcing are made on the basis of a thorough analysis and consideration of the real situation in the companies with the aim of achieving greater competitiveness, adapting easily to changes, improving business processes and ultimately increasing profits.

Logistics services providers need to be aware of differences in the demand for logistics services, and focus on developing and expanding the range of services by finding optimal solutions for every new challenge. Although this form of business has long been accepted in the market, there is still room for improvement in this area, particularly in the provision of logistics services, since the development of large companies is often focused on logistics providers that can provide the required work quality in those countries where they operate in a way that they easily adapt to specific market requirements.

The implementation of a management system in accordance with the quality and environmental protection related standards (ISO 9001, 14001, HACCP, IFS, Qudal) imposes new trends in logistics processes, too.

Logistics services providers are often under pressure from their clients, customers, and the community because quality management and active environmental protection are tasks of all participants in the chain, from producers to consumers, in order to fulfill the daily goal of maintaining a sustainable competitive advantage.

For this purpose, they have turned to advanced technologies and achieved some improvements in relation to customer satisfaction, cost reduction and environmental protection, such as real-time transportation optimization in shipping, storage capacity optimization, improvements in relation to goods manipulation and adequate storage, sorting, order picking and distribution of goods.[7]

The key drivers of the logistics market are increased investments in infrastructure and improved business efficiency achieved by companies focusing on their core competencies and outsourcing related services.

The economy of Europe accounts for 29% of the world's GDP and the logistics industry accounts for 5% of Europe's GDP.

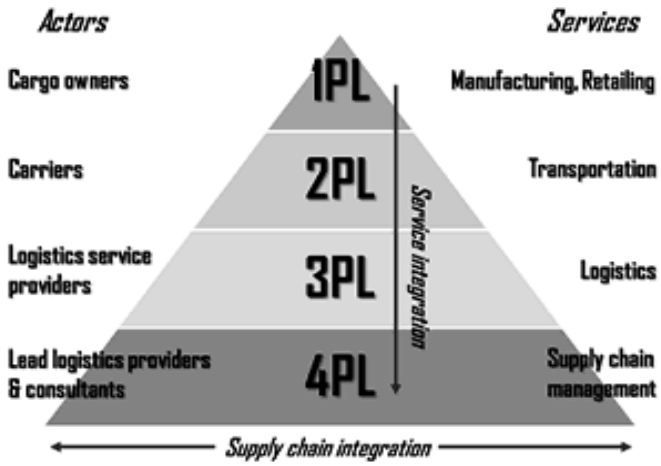
The logistics market is expected to witness steady growth during the period 2015-2019. The estimated value of the European logistics market in 2014 amounted to 1,128.62 billion USD, while over the period 2014-2019 steady growth is expected with a CAGR (i.e., compound annual growth rate) of 2.97%. The European Union and European coun-

tries have promoted initiatives for the development of roads and transport services in Europe stimulating in this way the growth of the European logistics market. Hence, for example, during the period 2007-2013 the EU invested 9.57 billion USD in 327 projects related to logistics infrastructure.[8] Significant progress in the development of the logistics industry in the Republic of Croatia took place after Croatia's accession to the EU on 1 June 2013, which caused the European market to open and necessitated some new business adjustments from market participants. In 2014, the Croatian logistics industry consisted of 3,126 active logistics service providers, i.e., 99.46% small and medium-sized logistics service providers, and only 0.54% large ones. The concentration coefficient of the Croatian logistics industry indicates that the top 10 performing logistics service providers in Croatia hold 33.81% of the market. This is moderate concentration, but it is expected that it will grow.[9]

In addition to increased infrastructure investments, a key driver of the logistics market is increased business efficiency of the companies achieved by focusing on their core competencies (Christopher, 2016: 19) and outsourcing services for other segments of their business which are not their primary activity and imply high operating costs, implementing JIT (Just-in-Time) manufacturing strategy (Bloomberg et al., 2006: 8), and the development of e-commerce that influenced an increase in the demand for efficient logistics services. By using 3PL or 4PL service providers[10] manufacturing companies are able to increase their production capacities and expand their business in general by focusing more on their primary activity (i.e., core business). Figure 6 shows what providers imply.

As shown in,[11] compared to the 3PL concept where the focus is put on the execution of tasks and transportation contracts, the 4PL concept is focused on the integrated logistics process, management, intellectual capital and modern technologies.

Figure 6 Providers



Source: Logistika.com.hr, "Koja je razlika između 3PL i 4PL? -1.dio"[12]

The development of logistics and information technologies has initiated new concepts of logistics operators, such as 5PL (business expansion on the Internet, used in transformation of the supply chain into the supply network) and 7PL (a combination of 3PL and 4PL, i.e., one service provider can provide both 3PL and 4PL services to the client and it represents fully outsourced logistics, where all services are placed under one roof).[13]

From the above trends we can see that the need for efficient logistics and additional services will grow in the future, and with more complex requirements companies will force logistics services providers to invest in information and communications infrastructure and other technologies.

5.1 Digitization and green trends in logistics processes

Faced with increasing competition in the logistics service market, companies are beginning to optimize their own processes relying on digitization, which brings the challenge of coordinating and channeling a large amount of information collected at the right time in the right place. Depending on the needs of the company, it is necessary to "smartly" choose the software that would enable a better overview of the activities, and ultimately, by means of the obtained data, to efficiently direct them towards the necessary optimization of the work process. The tendency today is to store business information in one place, the so-called "cloud", from which it would be both available at all times and protected from unwanted users. The specific features of doing business logistics require constant development of new technologies or application of the existing ones in new forms. As an example, we mention a technological tool that manages distribution in the cities, where technologies enabling the development of optimal routes by which goods should be distributed are most frequently used, and for further destinations they must undergo technological processing with respect to a larger number of parameters preventing loss optimization in doing business (e.g., drivers' hours and working time rules on longer routes determined by the law of the state where the company is registered, etc.).

In addition to their own interests, major logistics companies have recognized the importance of corporate social responsibility. Besides ensuring the optimization of their own resources, companies have started to care about ecology as a guarantee of sustainable development. Usage of advanced technologies reduces fuel costs, optimizes the use of delivery vehicles, but also contributes to the reduction in CO_2 emissions and environmental protection. Many states have passed their own acts governing and imposing this form of innovative strategies on businesses thus driving the leading companies to make profitable long-term investments in technologies and use them (e.g., the use of small and large electric vehicles and, in urban transport, the use of cargo bicycles and tricycles). The development of intermodal logistics is significant for long-distance transport of goods in terms of both environmental protection and cost optimization, i.e., increasing the use of rail, sea and river routes, as well as transport of goods by air, thus removing a large number of trucks from the roads. The development of multimodal transport brings many benefits to the economy in general, so in relation to this issue, significant steps towards changing the existing situation should be made in the Republic of Croatia. Hence, a new strategy for the development of the transport system in accordance with the European transport system is necessary.

6. Examples from practice

This section is dedicated to the analysis of the improvement of the operation of certain companies in the Republic of Croatia for the purpose of optimizing the costs of logistics processes. It also gives an example of a leading logistics company RALU d.o.o. that operates in the Republic of Croatia, Serbia and Slovenia and is a reliable logistics partner to many Croatian and international companies which seek highly standardized logistics services in accordance with European standards. As a result of a large number of logistics services offered in the market and greater competition in this segment, companies are increasingly becoming aware of the fact that logistics activities should not be only supporting activities.

Global competition imposes higher standards. Reorganization of business processes, coordination of business operations and increased efficiency are the results of investments in the development of logistics or cooperation with external partners on the performance of logistics activities.

Economic operators in Croatia are trying to round up the production process starting with raw materials to the sale of finished products. The performance of all activities within a company, including the logistics ones, makes Croatian products less competitive in the international market because quality performance of each individual activity necessitates continuous investment in technology without which business becomes unsustainable.

Although there is a growing awareness of the importance of outsourcing services, the role of logistics intermediaries in Croatia is still mostly related to freight.

Table 2 shows the significant progress made by several Croatian companies in the development of the logistics process as a result of collaboration with LOGIKO, a business education and consulting firm specialized in logistics and procurement.

Table 2 Improvement of business processes to improve logistics of a company

ROTO DINAMIC d.o.o.	**Result: Optimization of warehouse processes**
Processes:[14] • implementation of new organizational structure, • defining the position of logistics in the matrix organization structure, • finding and establishing the logistics management staff	
DREZGA d.o.o.	**Result: Inventory optimization by 20% Optimized order time**
Process:[15] • company's inventory was reduced by applying an inventory optimization method, designed by a consulting firm, that consists of six steps, each of which represents an important component of inventory management, with the goal to manage inventory as an instrument to achieve the sales strategy and overall business objectives, • the model was set by means of which a long and tedious process of ordering has been eliminated from operational procurement.	
Elektrocentar Petek d.o.o.	**Result: Master data management More adequate use of ERP systems**
Process:[16] • the state of the warehouse was recorded and it was found out that the ERP system was used inadequately, but also that master data were of poor quality, which led to communication problems between the warehouse and the technical service unit and consequently the warehouse was not able to meet customer and technical service demands timely and accurately; moreover, a discrepancy was found between the recorded and actual inventory and duplication of codes was identified in the IT system, • after analyzing the needs and possibilities of the IT system in the field of master data, adjustments were made which removed the causes of master record duplication, and ultimately the number of item codes was reduced by 37%, which resulted in easier and faster code search and fewer errors in receiving and releasing goods, • a procedure was developed for the entry of new codes (master records), and the entire process was centralized in one department; the new procedure reduced the number of duplicate codes	
Aluflexpack d.o.o.	**Result: Optimization of production processes**
Processes:[17] • new ways of implementing production processes were designed and created, • production processes were prepared for their computerization throughout all stages of production and across several factories within the AFP Group in order to achieve high-quality automation	

Source: Created by authors on the basis of sources listed in the table

Guided by the above examples, we can conclude that the use of consulting services and continuous training within the company could contribute a lot to the development of skills and the acquisition of new knowledge of procurement and storage optimization, inventory and manufacturing process optimization, and total logistics costs reduction.

Narodne novine d.d., Jamnica d.d., Gavrilović d.o.o., Milsing d.o.o., Zvijezda d.d., Viro d.d., Vindija d.d., Elektro-Kontakt d.d., DBT d.o.o., Carlsberg Croatia d.o.o., Podravka d.d., etc. can be listed as some positive examples of companies in the Republic of Croatia that have recognized these trends and automated their warehouses.

6.1 The development of logistics companies in Croatia

Most of the warehouses in the Republic of Croatia are owned by manufacturers, while the trend in Europe tends to separate logistics from the company's primary activity. If separated, this business segment necessitates large investments in IT technology to minimize errors in the daily work relating to faster flows of goods and services from manufacturers to consumers.

Historically speaking, warehouses were cheap buildings with nothing but concrete walls, but nowadays it is almost unacceptable to store the goods in such facilities. For this reason, there is a need for unified storage facilities and construction technology that would imply higher building and maintenance costs. Many companies have therefore recognized the importance of outsourced logistics services, but still not enough.

Although much has been recently done in the Republic of Croatia in terms of modern storage capacities, there is still a chance for developing companies offering logistics services. The world's 70% of logistics operations have been outsourced to logistics specialists, and in Croatia this ranges between 30% and 40%.[18] Companies with logistics services as their main business activity are faced with more complex requirements regarding new services offered to their customers (from warehouse design and its concept to operation modes). In order to provide clients with the required services at affordable prices, the companies are increasingly shifting the focus of their activities from capacities to processes (by working on the optimization of work processes and costs associated with them).

In this paper, the logistics company RALU is mentioned as a positive example of providing logistics services in the Republic of Croatia. They are specialized in providing high-quality logistic services in accordance with European standards.

Aware of the need for daily logistics planning and controlling of their efficiency to ensure a safe delivery at the right time and at the lowest possible cost, they continuously assess KPI (i.e., key performance index) values. In order to control costs, they continuously measure logistics performance, such as the efficiency of the existing logistics capacity. Such company defines its mission and strives to achieve it every day.

When designing and building their new warehouses, they have been focused on efficiency and optimization of working space. The flexibility to expand the existing capacity to meet clients' needs is considered to be particularly important.

The use of modern information systems and new delivery vehicles of their own (the company owns more than 180 state-of-the-art vehicles - tractors, refrigerated vehicles and semi-trailers) ensures chain traceability and integrity starting with entry of goods into the warehouse to delivery of goods under controlled temperature regime in the entire Croatian territory, but also in Europe. Fulfillment of special storage and delivery requirements set out by service users makes traceability particularly important given that this company also deals with logistics operations related to pharmaceutical products. By following the trends in their new storage facilities they have automated part of warehouse operations, but have not excluded the human factor because they believe that although state-of-the-art technology is most expensive, it does not automatically imply that it is optimal. For example, high-bay automated warehouses are definitely modern warehouses that do not require much physical work, but such warehouses do not always represent the optimal solution for all services required by logistics companies.[19] They use a WMS (Warehouse Management System) in their operation, i.e., a system managing all processes in the warehouse enabling greater efficiency and accurate and fast information necessary in today's logistics.

All of their vehicles are equipped with sophisticated and modern equipment for communication and monitoring operating parameters of vehicles, the condition and temperature of goods in real time and are connected with the GPS tracking system.

The logistics company RALU adapts its services to meet customer demands and expectations starting from offering complete logistics solutions to only some parts of logistics. Their services range from

transport of goods from any warehouse or facility located in Europe and Russia, keeping goods at certain temperatures, order picking, labeling, repackaging and other services, to delivery to a retailer.[20]

7. Conclusion

Inappropriate logistics solutions can lead to lead to high costs being borne directly by the company, missed deadlines, business failure or similar business problems.

The digitization of business processes is necessary in all spheres, including logistics. Given the close link with the IT services, it is necessary to monitor their development trend. Being aware of competitiveness in the logistics service market, companies are increasingly working on optimizing work processes relying especially on the optimization of the flow of information between the parties, and trying to make work processes faster and more transparent.

Learning and acquisition of skills referring to application and adjustment of the new information technology is crucial for management and optimization of logistics processes because it enables secure communication, more precise and effective work with a large number of business partners. Logistics has become a business function focused on savings and earnings, and there is a need for more logistics centers that would support the work of the company.

Due to its geographical position, the Republic of Croatia has an important strategic position in South East and Central Europe, and globally speaking, it is a very interesting destination for logistics companies. However, there are certain challenges for logistics service providers operating in Croatia, such as the specific shape of the territory, a large number of islands, and the necessity of passing through another country (i.e., Bosnia and Herzegovina) to reach some parts of the territory of the Republic of Croatia, that imply demanding logistics operations. Other particularities, such as seasonality of work (for 2 months during summer, turnover triples in relation to the rest of the year, especially in the coastal part of the country), make logistics in the Republic of Croatia very demanding. Due to its complexity and difficulty, it has not been very interesting to foreign logistics companies. These are mostly the reasons why they have started to enter the Croatian market slowly through their partners, i.e., Croatian logistics companies provide logistics services on the Croatian territory as their representatives. This enables local logisticians to manage foreign business operations on the territory of the Republic of Croatia, but for the purpose of establishing high-quality cooperation and implementing planned investments in modern infrastructure this has become a necessity.

Investment in information and communication technologies and their use in logistics processes would result in the fulfillment of needs of individual users, the successful implementation of business activities, improvement of service quality by creating conditions for better customer service, optimizing the time required for the provision of services, reliability of delivery times, ensuring and protecting the goods but also by improving the image of the company.

Increasing attention is paid to greater investments in process automation and networking, and in the development of mobile data communications, software for disposition in order to get more accurate overviews of business activities and to facilitate productivity measurement.

The aforementioned is a prerequisite for the development of integrated logistics (all under one roof concept) as a new trend that brings down total costs, minimizes the possibility of errors, and enables more efficient management of inventory and all processes in the supply chain, and results in higher overall productivity. This solution is recognized by many companies as ideal for their business as it reduces costs and improves the quality of work.

The contribution of this paper is reflected in the analysis of available secondary sources used to identify the trends in using information technology in the management of logistics systems. They form the basis for further research in this direction, the purpose of which would be to offer proposals and contribute to science in order to improve logistics processes in companies.

Research into profitability of investments in certain technologies can be mentioned here as an open question and recommendation for further research. Given the need for doing the planned work, the question is to what extent to invest. There are also some other questions that need to be answered: when should a decision be made; should the company invest in automated or semi-automated warehousing systems, or would it be optimal to run manual warehouses due to business capacity?

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TRENDOVI KORIŠTENJA INFORMATIČKE TEHNOLOGIJE U UPRAVLJANJU LOGISTIČKIM SUSTAVIMA

Sažetak

Na tržištu se sve više koriste suvremeni logistički sustavi koji kao dio upravljačkoga sustava moraju jamčiti proizvodnu fleksibilnost, potrebne dobavne termine, dobavnu pripravnost za prodajno tržište te odgovornost za vezivanje kapitala u zalihe. Globalizacijom tržišta nameće se nužnost ispunjavanja određenih standarda u poslovanju koji su jamstvo kvalitete odrađenoga posla. Korištenje informacijsko-komunikacijskih tehnologija te njihov razvoj u cilju potpore individualnih potreba korisnika sve je značajnije za uspješno provođenje poslovnih aktivnosti. Radom je analizirana uloga informatičko-komunikacijske tehnologije u logističkim procesima, te integraciji logističkih sustava. Primjerima iz prakse potkrijepljeni su razlozi sve većeg ulaganja tvrtki koje se bave ovim segmentom posla u svrhu optimizacije rada i povećanja profita, te je ukazano na značajnu ulogu informatičke tehnologije u logističkim operacijama, dosadašnje rezultate te primjene, ali i na buduće moguće primjene.

Ključne riječi: informatička tehnologija, upravljanje, logistički sustavi, logistički procesi, optimizacija