



Digital Transformation and the Development of Telematics in the Context of Digital Supply Chain

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ABSTRACT

Today's market and customer expectations are changing so fast that numerous solutions and logistic concepts are becoming obsolete or require radical changes. These changes largely result from digital transformation, which creates a new business reality, generating access to digital tools and services in any place, at any time and scope. Owing to digital transformation it is possible to apply technology which ensures visibility throughout the supply chain, real-time response, implementation of modern E2E concepts, and primarily solutions that will allow to effectively meet the expectations of the modern customer. In this respect, it could be useful to consider the place of telematics in meeting these requirements and expectations. The assumed increase in effectiveness of activities, real-time data exchange and automation of many processes without the broad implementation of telematics considerations seems impossible. Thus, the question arises not only about the role and importance of telematics, but also about the scope and areas of implantation of telematics solutions into the functioning of modern supply chain referred to as "Real-Time-End-to-End-Visibility". The article attempts to identify and comprehensively approach the factors determining the emergence of such solutions. The objective of the study is also to indicate trends and directions of changes in the implementation of the latest telematics solutions on the example of selected companies in Lower Silesia.

KEYWORDS: digital transformation, AI, IoT, development of telematics, E2E, Visibility

1. Introduction

Contemporary economy becomes an economy of flows and dynamic development of the network of connections. Thanks to such an organization, it is possible to react faster to changes, including quick adjustment of the production scale to market requirements and permanent reduction of costs by both large and medium-sized companies. The economy is becoming more and more flexible and quickly reacting to changing market niches under the influence of ever faster innovation streams. What is new in logistics appears in response to two phenomena: increasing complexity and abstruseness of tasks and increasing pressure on process flexibility.

That is why today, on the market of logistic services, information and the time of its acquisition and processing become the key elements of running a business, including any other sector of the economy. Thanks to the still growing technical capability in the area of acquisition, processing and data collection in combination with dynamically developing 5G technology, the use of which allows sending information packages of unprecedented size to a virtually unlimited number of recipients. It should be remembered that 5G technology is not fully developed yet, and it must be stressed that in many places, both in Poland and in the world, 4G technology has not yet been implemented. This means that many users still do not have access to the super-fast internet, both in the fixed line and mobile technologies with fourth-generation parameters.

Bearing in mind the dynamic development of digitalisation and the ever-growing popularity of mobile devices, which are eagerly used by individual users and all kinds of corporations, for which public administration tries to keep up, even creating the right law stimulating the development of the necessary thematic and ICT infrastructure. The development of the indicated infrastructure is now necessary because smartphone and tablet users acquire, consume and send more and more data. Just as the amount of data sent via the Internet is growing, the number of users is also growing. According to Internet Live Stats, the first billion internet users were exceeded in 2005, eleven years later, i.e. in 2016 in the world this result was at the level of 3.4 billion users. This means that at that time about 46% of the world's population had access to the network, sending about 200 billion messages every day by e-mail, searching for 3.4 billion Google passwords, generating internet traffic of 2.2 billion GB. Over one billion websites existed at that time [1].

The importance of the development of telematic and digital solutions and the importance of this area for the functioning of the country is also noticed by the Polish government, which indicates that ICT is the most promising direction for the development of the state. It also assumes that these solutions will have wider and wider application not only in the industry and life of an ordinary citizen but also in public administration. Being careful at the same time that the tools mentioned above will contribute to the growth of the country's economic development. The Polish government indicates that digital development is a discipline that develops extremely dynamically. What is extremely important still surprises with its range and the way it impacts on everyday social and economic life [2].

In the report entitled 'IoT in the Polish economy, Report of the Working Group on Internet of Things' prepared for the Ministry of Digitization in 2019, aptly pointed out that both in the past and the present we are unable to precisely determine in which direction the digital industry will develop and what solutions technologies will be implemented for everyday use. In connection with the above, in the government's activities regarding new technologies, it is necessary to adopt new solutions that will be more adapted to the changing areas of the digital environment. In practice, this means, *inter alia*, 'wider use of the so-called an intelligent law, i.e. one that rather than arbitrarily identifying specific techniques or actions, rather defines the goals and rules of conduct that can be followed despite progressing changes in the environment. This is the construction of both the personal data protection law and the constitution for business or the national cyber security system [2].

Regardless of government policy, the market functions and also creates a series of answers to challenges related to the revolutionary development of digital and telematic technologies. The 21st century brought about the development of the digital transformation of various spheres of human economic activity, which somehow forced a number of organizational changes in the logistics industry. Particularly noticeable changes have occurred in the operation of supply chains, as well as the links between these chains and public administration, and entire economies [1].

In connection with the above, the purpose of the article is to present an analysis of the impact of telematic solutions on the functioning of the supply chain. The work is based on: literature

analysis of the subject and statistical data obtained from enterprises offering their services in the TSL industry.

The study uses a method of system analysis of information focused on the analysis of secondary sources. The monographic method, statistical methods and methods of comparative analysis were used. The results of the research were presented using descriptive techniques, tabular techniques and graphic techniques.

2. The effect of applying telematics tools and systems on the functioning of the digital supply chain

In the report prepared in 2011 by MIT Center for Digital Business and Capgemini, digital transformation was defined as the use of digital technologies to dramatically improve the performance or achievements of the organization. It means that it affects the three basic areas of each organization, i.e. [3]:

- experience of the organization's clients and more precisely understanding the clients' needs,
- introduction of many channels of communication with the client and clearly marked elements of self-service, defining operational processes, i.e. internal processes of the organization and work environment, as well as performance monitoring mechanisms,
- operational model of the organization, i.e. what products / services the establishment provides and on what markets.

It should be noted that the development of the Internet, digital and telematics tools connected with telecommunications technologies is now the basic principle of every economy and developed society. In countries, enterprises and societies, the ubiquitous communication of everything with everything is no longer surprising. Today, the network is connected to all government administration, enterprises in the supply chains, a single citizen and his coffee maker, refrigerator, washing machine and the house in which they are located. This situation was named by Canadian scientists Anabel Quan-Haase and Barry Wellman as hyperconnectivity while their research on human-to-people (P2P) and human-to-machine (P2M) interactions in organizations and network communities [4].

In the DHL "Logistics Trend Radar" report for 2016, twenty-six key trends and challenges for modern logistics were identified. What is important, most of them are directly related to the development of artificial intelligence. The indicated report provides for the development of intelligent supply chains, using systems of self-learning or self-learning using a computer, and the promotion of the batch size one and on-demand delivery options. The on-demand delivery option created for exerting a significant influence on logistics will enable consumers to deliver their purchases to the place chosen by them and the time they have established through the use of flexible courier services [5].

The implementation of the current process of transformation of the economy is primarily a number of changes in management forms, a departure from traditional assumptions for those who have theirs in cyberspace. This refers to the introduction of

increasingly better computers, computer programs whose task is to support management. Dynamically developing enterprises, which nowadays want to modernize their management systems should consider the implementation and use of logistics concepts based on available modern digital technologies and technologies as well as high-speed data transfer technologies (5G technology). At the same time, it should be noted that the assumptions for the new generation 5G mobile network will offer data rates from 10 to 100 Gbps. For comparison, currently developed LTE technologies allow access to the Internet with a bandwidth of up to 300 Mbps [6]. In addition, mobile network operators ensure that the 5G network is characterized by very low latencies, reaching only a few milliseconds (or even less), which is a very high standard compared to current standards. In addition, the 5G technology is to be almost completely resistant to the decrease in performance associated with a large number of users using it at the same time. All thanks to intelligent bandwidth management [7].

Bearing in mind the rapid development of digital technologies, telematics systems and devices as well as 5G technologies, it should be emphasized that today's development of logistics companies and their place in the supply chain depends on their adaptation to digital reality, which consists of the previously mentioned components and a series of other components. Which means that today to survive in the market of logistic services, it is not enough to have a super product, you need to have the right information and use it skillfully. Many entities in the logistics sector state that decisions taken in their chains must be carried out on the basis of automaticity, because they cannot afford to waste time on reflecting on the decision. The time rule is still valid. This situation forces companies in supply chains to increasingly broader integration. This integration concerns both the flows of raw materials and related information. What is extremely important today to achieve an advantage in the market of logistic services flows of information between entities are necessary and it is important that the time of their transfer is as short as possible, which now thanks to the implemented 5G technology becomes not only feasible but even necessary. The model of using the 5G network in the flow of information in the logistics network is presented below in Fig. 1. It can be argued that in the future, effective management of flows in the logistics network will not be possible without properly prepared infrastructure 5G, which will have a lot more functional connections than any currently functioning modern logistics network.

In connection with the above, the current supply chains can be called digital. Their development can be presented in a circular motion, where the development of one element is a catalyst for development for the other. The ongoing digital transformation is inextricably linked to the interrelated relationship between telematics, artificial intelligence, the internet, and communication. Which in turn translates into the processing of digital data, process automation, digital access to information of exchange participants and the communication that takes place between them practically bypassing the time barrier.

Today, the delay associated with the delivery of messages is measured in microseconds. This means that in the future a large part of the information will be processed only by the computer, because the man himself will not be able to process such a large database in a short time. It should be noted that biometric telematic systems

are already being tested, by means of which dangerous people are sought, and vehicles on the road decide themselves to take control in order to avoid an accident. The above-described dependencies affect the need to redesign the structure of supply chains, which from traditional to digital. The digital transformation of the supply chain is shown in Fig. 2. Its course can be closed in a closed cycle, which is infinite, because the development of one element causes the growth of another. We are now witnessing the fourth industrial revolution, and on the horizon there is already the fifth connected with the development of telematics and the digitization of economic and social processes.

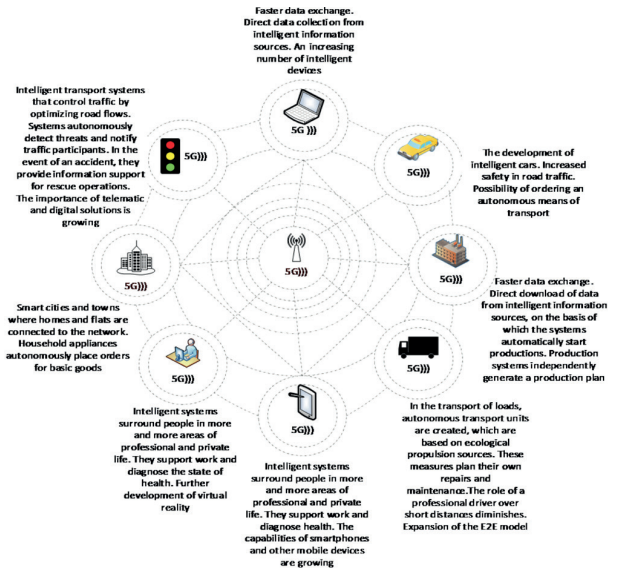


Fig. 1. Application model of 5G network in the flow of information in the logistics network [own study based on 7]

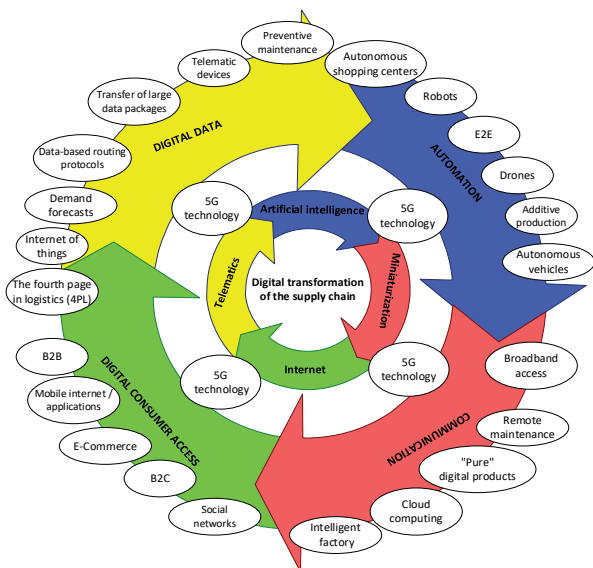


Fig. 2. Factors driving the digital transformation of the supply chain [own study based on 9]

Today, data acquisition is not unusual. Each entity collects data about its products, customers and products offered by its partners and competitors. The multitude of information gathered in an enterprise without their proper processing and use seems to be pointless. For example, in a factory that generates about 4 billion samples of information per year, and one sample is equivalent to one reading from the machine. It will not do much to gather only the information in the system. Only their proper analysis results in the elimination of downtimes, unnecessary mileages, and this will turn into a cost optimization. How important is the synchronization of processes is testified by the results of the study of ‘The Digital Factory: Game-Changing Technologies That Will Transform Manufacturing Industry’ conducted by Pierfrancesco Manenti, where 47% of surveyed manufacturers believe that Big Data analytics will have a huge impact on their enterprises’ performance and will be the core of digital factories of the future, and 49% of respondents expect that it will reduce operating costs and contribute to the more efficient use of resources [10].

What is extremely important, systems using Big Data have wider data processing capabilities than those known for traditional data analytics. This is due to the fact that the systems and forms of data collection and reporting that were and are used, and were based on Excel, or WMS or ERP systems are quite limited in their operation, through limited access to small databases, which allow you to delve into all the necessary data at a sufficient level, and at the same time both the companies themselves and the systems they own do not have adequate analytical algorithms. In addition, it should be noted that traditional systems are very sensitive to user errors. The biggest disadvantage of traditional systems is that in most cases the data is not connected in any logical way. It often happens that within one organization there are several operational management support systems that are in no way related to each other, let alone related to external entities. Where modern analytical software, using Big Data resources, is distinguished by the speed of generating reports, easily adapting them to the individual needs of their users [10]. What in connection with the possibility of free access to data and extensive possibilities of analysis and visualization, as well as unlimited data transfer, now enables online collaboration and guarantees mobility both within the organization and with external partners operating within the common supply chain.

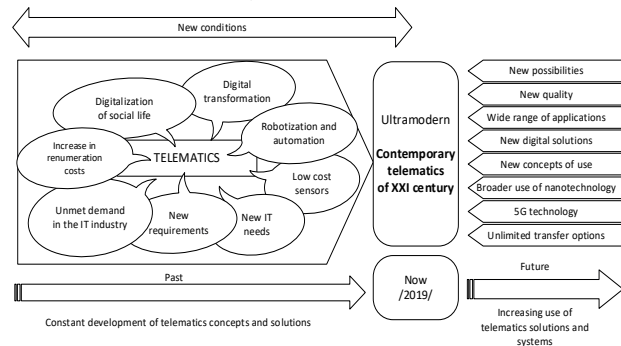


Fig. 3. Factors determining the development of telematics systems [own study]

In recent years, transport and production companies, but also service companies have been struggling with growing administrative obligations and increasing competition on the market. Therefore, the demand for innovative tools supporting and optimizing service provision is constantly growing. The telematics systems that influence the development of the logistics sector entities and the construction of logistic chains are extremely helpful in this. Currently, the development of telematics tools is so strong that its impact on logistics is undisputed, as well as the impact of logistic processes on the development of systems and telematics tools, as shown in Fig. 3.

The links between logistic chains and logistics processes in supply chains are very clear. The use of telematics tools has resulted in an increase in the security of cargo flow and information transfer. In addition, thanks to telematics, it has become possible to shorten the duration of most processes, which translated into a reduction of costs throughout the entire supply chain.

In connection with the above, one should ask how will the supply chains be built in the future and what will be the place of telematics systems in creating their structure, and what will be the future logistics processes in the near future? Answering the above questions is not easy, because in the world of logistics, many ideas for building future supply chains break through. It seems indisputable that the development of digitization will continue, which will lead to a change in the representation of the real world to digital. Digitalization will result in the need to accept the digital world as a complementary element of the real world. In connection with the above, the actual supply chains will have their digital counterparts. The most important feature of the future supply chains will be that they will be smart. The intelligent supply chain is shown in Fig. 4.

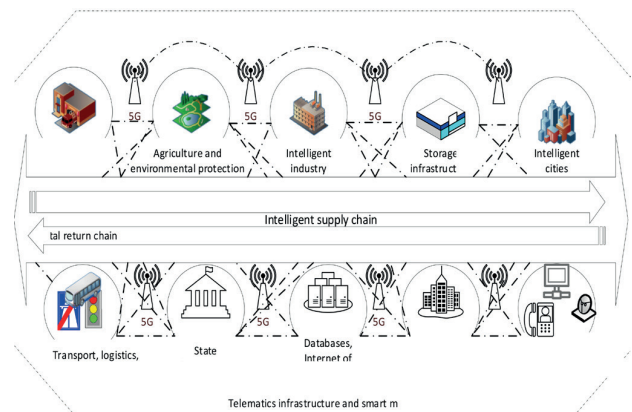


Fig. 4. Factors determining the development of telematics systems [own study based on 2]

The intelligent supply chain will be characterized by the ability to learn and they will have the ability to adapt to changing conditions. However, in order to be included in it, it will be necessary to connect to a common network that will operate on the basis of telematics systems, and the information collected therein will be sent at least using 5G technology.

It should be emphasized here that digital chains will not function in isolation from reality. Despite its increasing digitization and telematisation, they will function in parallel with other subsystems.

This is in line with the axis of the concept of the so-called Intelligent Cities, based on the digitization of urban space, which aims to create cities that are more citizen-friendly, more economical and ecological. From the technological point of view, the key element enabling the implementation of this idea is the previously mentioned internet of things, which is based on the concept of communication between devices (M2M - machine to machine) assuming the ability to communicate, collect and process data and their exchange through these devices through a computer network and on a properly prepared infrastructure for data transmission type 5G.

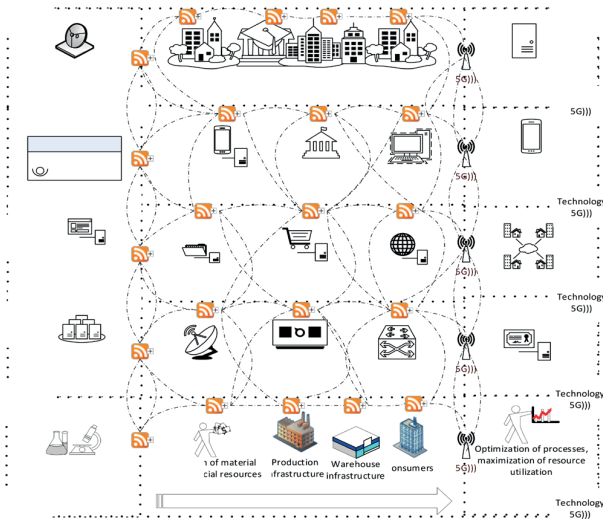


Fig. 5. An example of a diagram of connecting a smart city with a digital supply chain [own study]

The M2M model assumes communication between machines that perform specific tasks within the agglomeration. Similarly, devices can be communicated as part of a digital supply chain, which is not enough to connect a smart city with a digital supply chain. An exemplary scheme of such a combination is shown in Fig. 5. In simplified terms, this means sensorizing urban space, houses and buildings, and digital supply chain components to enable real-time event monitoring and / or information exchange between both machines and people. Thanks to this, it will be possible to increase the level of access to information eg about traffic, the level of occupancy of parking spaces or the needed light intensity, but also the level of production needs will be known, which will significantly optimize the use of available resources, and remove many bottlenecks in infrastructure as well as supply chains.

For the purpose of this article, research has been carried out in production companies in Lower Silesia. The survey was conducted at the turn of February and March 2019. A total of 100 entities were submitted to the survey using the interview questionnaire. The aim of the study was to check whether devices and telematic systems are used in the Lower Silesian manufacturing companies and what benefits and disadvantages have been brought by the implementation of telematics systems in the surveyed enterprises.

Out of 100 surveyed enterprises, more than half use telematic systems and devices. Most of the respondents, 57%, said that telematics systems are used in their companies (Fig. 5a.).

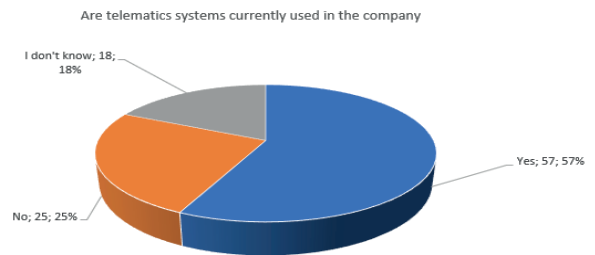


Fig. 5a. The degree of employees' awareness of whether telematics systems are used in their enterprise [own study]

Most respondents also believe that the devices and telematics systems used in the company have a positive impact on the operations of their company. 86% of responses were positive to this question (Fig. 5b), with only 9% of respondents reporting negative impact of telematics solutions on the functioning of the company.

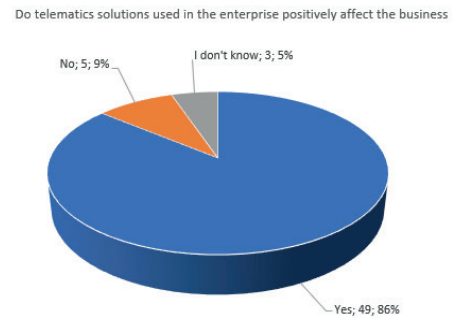


Fig. 5b. Do telematics devices have a positive impact on the functioning of the examined subject? [own study]

In the next question, respondents were asked to determine the benefits for their company in the implementation of telematics systems and devices. On the basis of the collected answers, it can be concluded that a certain group of benefits has occurred in each company. The most frequently mentioned include (Fig. 6): better use of human and material resources 35%, reduction of losses in production processes 35%, increase of the company's flexibility in the supply chain 28%, reduction of order processing costs 25%, reduction of untimely deliveries 24%, reducing the number of complaints by 20%.

The last question dealt with the negative aspects resulting from the implementation of telematic devices and systems. It turns out that the biggest disadvantages include the high cost of implementing new tools and telematics systems. This situation is reported by as many as 65% of respondents (Fig. 7). The second place was the reluctance of employees towards new solutions of 55%, followed by the following: downtimes related to the implementation of telematics systems 35%, the need to hire highly qualified personnel 25% and failure of devices for data transmission 25%.

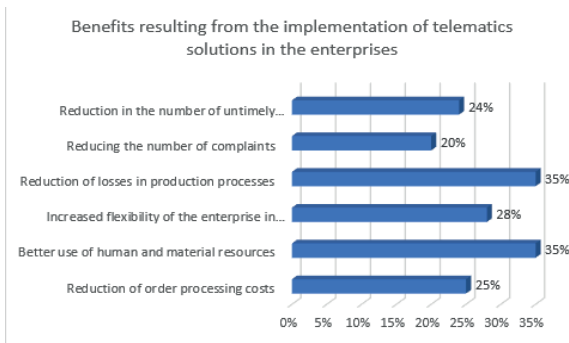


Fig. 6. Benefits resulting from the implementation of telematics solutions in the enterprise [own study]

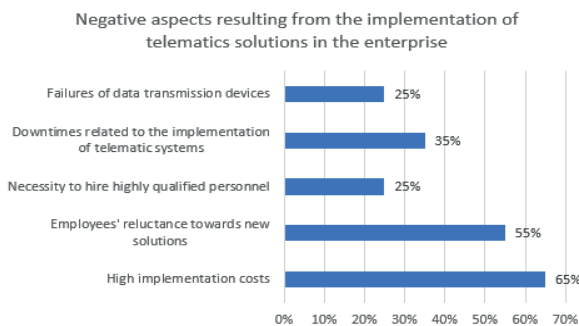


Fig. 7. Negative aspects resulting from the implementation of telematics solutions in the enterprise [own study]

3. Conclusion

The main factor stimulating the development of knowledge-based economy and, hence logistics, is intellectual capital. Knowledge-based economy and logistics is characterized by a production structure in which goods and services are included in the subject of export and consumption, containing a large part of the added value resulting from special human skills.

A sign of innovation and modernity in logistics and thus in the supply chain are not only solutions based on faster computers and 5G networks but, above all, man, his knowledge, innovation and way of thinking. Nowadays, it is not only about simple modeling of each process based on the obtained parameters, but also building systems that have the ability to learn and adapt to emerging needs, deal with information deficiencies. These systems must be able to generate forecasts, demonstrate the ability to react and adapt to change. In addition, they must communicate with other systems and, above all, meet the same requirements that are put on all ERP (Enterprise Resource Planning) systems.

Today's market and customer expectations are changing so fast that many solutions and logistic concepts are becoming obsolete or require radical changes. These changes are to a large extent the result of digital transformation, which creates a new business reality, generating access to digital tools and services in any place, time and scope. It is thanks to it that it is possible to use technologies that ensure visibility in the entire supply chain, real-time response,

implementation of modern E2E concepts, and above all any solutions that will effectively meet the expectations of the modern client. In this context, it is worth considering the place of telematics in meeting these requirements and expectations. The assumed increase in the effectiveness of activities, real-time data exchange and automation of many processes without the broad implementation of telematics considerations seems impossible.

Therefore, the question arises not only about the role and importance of telematics, but also about the scope and areas of implantation of telematics solutions into the functioning of the modern supply chain described as 'Real-Time-End-to-End-Visibility'.

The aim of the article was an attempt to evaluate the impact of selected telematics subsystems on the construction of a modern supply chain. It should be noted here that the benefits of using telematics systems in logistic chains are huge. On the basis of the literature, it can be stated that both European and Polish companies indicated a similar range of benefits from the use of telematics systems.

Summing up, on the basis of the conducted research, it can be assumed that both the use of telematics systems and devices increases the efficiency and effectiveness of using the company's resources, allowing for the optimization of expenses.

The presented research results allowed to formulate general conclusions in a very narrow scope of telematics application in the economic life of a human being. In the next stage, more in-depth research will be carried out and the scope of this research will be extended to the possibility of using other telematics tools towards a greater degree of their integration.

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