

Opportunities and Threats Related to the Introduction of Modern Information Technologies in the Supply Chain

Robert Mendruń

The International University of Logistics and Transport in Wrocław, Poland

Iwona Bożydaj-Jankowska

University of Economics in Wrocław, Poland

The pace of economic growth, despite the crisis bogey still appearing somewhere near, is taking on speed on an unprecedented scale in the history of the mankind. The number of inventions currently being the subject of patent procedures or the quantity and quality of implementations of various types of solutions that improve and facilitate our lives - both professional and private - leads to a situation that we treat these changes more often as a normal thing, which does not arouse our admiration. During the preparation for this publication, the main focus was put on finding the answer to the question whether we are able to observe these changes, define them and assess them. The correct identification and definition of the area of changes is only half of the success. The second important, if not more important, problem is the issue of proper naming and examining the threats that affect these changes.

Keywords: innovations in logistics, innovations in transport, IT solutions in logistics, Industry 4.0, the Internet of Things.

1. INTRODUCTION

While analyzing press articles, one comes to the conclusion that nowadays we live in times when changes in the industry broadly understood as logistics take place at an unprecedented scale. Enterprises, trying to adapt their services to customers' needs, optimize already existing processes and more and more eagerly reach for modern technologies, determining the directions of the changes that we will deal with in the near future.

These changes currently apply mainly to such areas as:

- automation of storage-related tasks,
- modern methods of identification and control,
- operations related to locating and relocating goods in optimal locations,
- preparation and completion of goods for shipment,
- use of modern communication techniques and data exchange, implementation of advanced WMS systems controlling all operations taking place at a given facility or group of facilities in a comprehensive and integrated manner.

In the case of other branches being in the scope of interest to the TSL sector (Transport Forwarding Logistics), which are forwarding and transport, we can also notice a huge qualitative and quantitative leap. In many cases, over the last ten years, we have obtained powerful tools to optimize transport processes and increase security in order to meet increasingly higher demands and expectations from both the customer and state and international institutions such as IATA[1], ICAO[2], IMO[3], the European Commission, American NTSB and many others.

The transport areas that are currently experiencing intensive development can be divided into:

- increasing safety in transport,
- autonomous vehicles,
- automation of devices and reloading systems,
- increasing the transport capacity of transport means,
- increasing the efficiency of traffic control systems in particular types of transport.

Most studies that deal with new technologies in TSL focus on the possibilities and opportunities that these solutions bring. Unfortunately, there are

few publications that try to compile a list of potential threats or dangers associated with the use of these solutions. In this paper we will try to look at the issue of threats in cases of applying new technologies.

2. INNOVATION MEASURES

If trying to present the full area in which we deal with innovations in logistics, we would be faced with the task of preparing a very comprehensive publication that would not guarantee the completeness of the data contained therein, because the number of commercial entities and research centers in the world currently working on this issue is huge. Where does such popularity come from? Logistics is an area where increasing efficiency and optimizing processes have a clear impact on a company's financial performance. Constant pursuit of optimization causes that in many cases it is extremely difficult to determine which areas in a company or functionality of a particular processes have been changed finally. In most cases, according to the Kaizen philosophy, it is a permanent process and we rarely reach the point where we can say with 100% certainty that the field has been completely modernized and we have achieved the final result. The effect can satisfy us but we should not cling to the idea that nothing more can be achieved in a given matter.

To understand fully the very essence of innovation, we should refer to the subject literature. Depending on the way it is viewed, one can refer to the concepts of such researchers as Ch. Freeman, E. Mansfield and S. Kuznets, who related innovations to inventions[4]. Some researchers, however, define innovation as a management process [...] leading to creation, development and introduction of new values in products or new combinations of measures and resources that are novelties to the entity which creates or introduces them. Innovations perceived in a broad sense also include transferring these values to existing or new market partners, and can be the result of group work of enterprises.[5] In this way, innovations were perceived by such researchers as A. J Herman, E. Hagen, J. Parker, R. Johnston, and P. R. Whitfield.

Most often, however, one of the main concepts when relating to innovativeness is the one by J. Schumper. It is one of the most well-known and most frequently cited definitions. He defined innovativeness as [6]:

- improving already manufactured products and introducing new ones,
- introducing new production methods and improving the existing ones,
- activating and opening new selling markets,
- actions aimed at modernizing and applying new selling methods,
- modernizations in the field of production organization,
- use of new types of raw materials and materials.

It can be stated that due to the universality of this definition, it refers to almost every area of business activity.

The World Bank in the course of its statutory work uses huge amounts of data which it collects and develops a series of interesting analyzes regarding global economy. One of the areas analyzed is logistics, defined in a broad sense. Special attention should be paid to LPI (Logistics Performance Index) - logistic efficiency indicator. This indicator allows for a synthetic assessment of the logistics industry quality. The report shows the condition of logistics systems in 160 countries (state as of 2016). In the last ranking, the index for Poland slightly deteriorated, which also resulted in its lower position.

Table 1. LPI index describing Poland's position in the years 2007 - 2016.

Year	Position	LPI index
2016	33	3.43
2014	31	3.49
2012	30	3.43
2010	30	3.44
2007	40	3.04

Source: own study based on data from The World Bank [7].

Countries that invariably are at the forefront of the ranking are highly developed countries of Western Europe and countries in which logistics determines their strong economic development. Below one can see each country's position in the world in the form of a map:



Fig. 1. LPI index describing Poland's position in the years 2007 - 2016.
 Source: own study based on data from The World Bank [8].

Analysing the data one can get an impression that the position of Poland is as satisfactory as possible. Against the background of global regions, we rank above the average, with the value of 2.88. This is illustrated by the graph below:

More interesting, however, is to look at this index in the context of other countries with a similar LPI, with a similar level of development. This is shown in the table below.

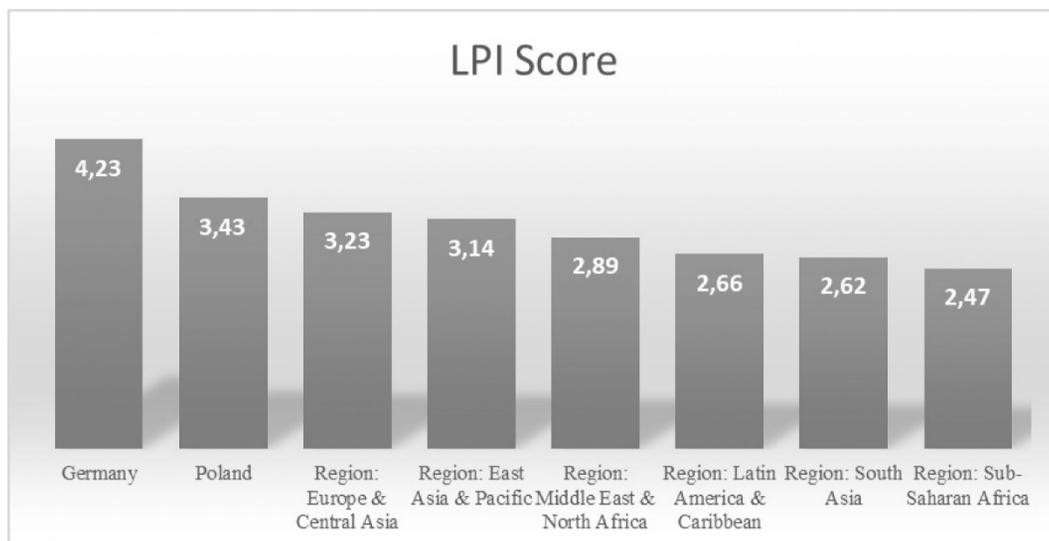


Fig. 2. LPI of Poland (2016) against the background of the German economy and other regions in the world.
 Source: own study based on The World Bank [8].

Table 2. LPI of Poland in relation to other countries with similar assessment.

Country	LPI
Taiwan	3.70
The Czech Republic	3.67
China	3.66
Israel	3.66
Lithuania	3.63
Qatar	3.60
Hungary	3.43
Malaysia	3.43
Poland	3.43
Turkey	3.42
India	3.42
Portugal	3.41
New Zealand	3.39
Estonia	3.36
Iceland	3.35
Panama	3.34
Slovakia	3.34
Kenia	3.33
Latvia	3.33
Bahrain	3.31

Source: own study based on The Word Bank [8].

The most important thing is to analyse this index in the context of its immediate environment. Such an analysis can show the real level of Poland's development.

Poland compared to other European countries ranks on the average level with its 19th position (with two other countries at higher positions having exactly the same score as Poland). Taking such a distant position could indicate that the situation in Poland is not satisfactory, but analyzing the LPI of Poland compared to the countries of the "old union", the so-called mature economies, Poland is ahead of three of them: Portugal, Iceland and Greece, from such perspective the situation does not look so negative. Similarly if we compare the LPI of Poland to other "new" EU countries. only the Czech Republic and Lithuania are in front of Poland and Hungary scored the same result. Looking at the position of Poland in relation to other countries over the past years, it shows that the decline of Poland's position results more from the stronger development of its neighbours than from its weakness.

According to the World Bank declaration, LPI is an interactive tool for comparative analysis, the purpose of which is to help countries to identify the challenges and opportunities that are related to their effectiveness in logistics. There are six areas that are considered for assessment:

1. Customs issues - efficiency of processes related to customs clearance (including,

speed, simplicity and predictability of formalities) performed by agencies and customs authorities,

2. Infrastructure - quality of commercial and transport infrastructure (e.g. ports, railways, roads, information technologies),
3. International shipments - ease of organizing,
4. The scope and quality of logistics services,
5. The ability to track and control shipments,
6. Timeliness of transport

The sum of the above mentioned criteria constitutes the position of the given area (country, group of countries or area) in the ranking.

3. AREAS OF INNOVATION

The vast majority of introduced changes in the TFL industry are due to enterprises that want to meet customer expectations, try to optimize the processes taking place in their organizations or develop new solutions that will enable them to perform services in a more economical, efficient or ecological way. Are all the criteria mentioned in the previous part of this report in the interest of these companies? The analysis below will try to provide the answer.

In the further part of this study, results of the research that was carried out during many meetings with specialists from the TFL industry will be presented. All participants of the research are employees of logistic or transport companies with many years of experience. The knowledge obtained through interviews but also surveys, which gave ease of conversation and were consulted on an ongoing basis with the researcher, certainly does not exhaust the topic, in particular that the duration of the research was quite short (the meetings with the respondents lasted from July to September 2017) and the number of the respondents was only one hundred and sixty people, but according to the author's appraisal, the results give an idea of how innovations look from a practitioner's point of view. Some of the respondents who had been surveyed took part in further interviews, which also provided a huge amount of information. The collected information is presented below as grouped data.

At the beginning, the respondents were divided into two groups. The first one were representatives of companies related to logistics and warehousing. The second were employees related to transport and forwarding. There was prepared a separate survey for each group. The respondents declaring

activity in all the above areas were allowed to provide information for both the first and the second survey.

The first question concerned the issue of innovation occurrence in the further or closer environment of the enterprise in which they worked. A very large percentage of as much as 85%³ of the respondents noticed in their companies areas in which innovations occur. Due to the fact that the respondents were people who were met at various conferences, industry meetings or trainings, it should be emphasized that the answers to this question could have been a little bit over representative. In connection with the above, the question was used only for the purpose so that further questions of the survey could have been answered only by those, whose answers will provide relevant information on the study.

Then, one hundred and fifteen respondents who indicated as an area of their interest - an area associated with logistics - were asked a multiple choice question with an option for a respondent's own answer. The question was: Which areas of new technologies are the most important in logistics; the answers are presented in the table below.

Table 3. The answers to the question regarding the most important areas of new technologies in logistics development.

Innovation area / Logistics	Value [%]
Logistics 4.0	35
Implementation of WMS, ERP, MRP, MRP II	27
Automation of warehouse processes	15
Effective management	13
Process monitoring	6
Others	4

What message do individual answers carry? During the interviews with the respondents one could observe a considerable interest (up to 77%) in new technologies. Very often, these solutions are based on modern electronics, computerization and robotization (automation) of operations that take place in warehouses. Most of the respondents were interested in the solutions proposed by Bosh Company, based on the concepts of Industry 4.0 (the so-called fourth industrial revolution). The solutions prepared at the request of the German

³. for practical reasons throughout all the study, the results expressed in percent were rounded to full unities

government indicate the directions in which industry should develop to meet ever-increasing requirements.

Industry 4.0 is a very broad term. According to the above-mentioned study, the fourth industrial revolution is mostly characterized by the creation of super intelligent factories with cyber-physical production systems that are developed in the following surrounding [9]:

1. The Internet of Things (Intelligent Mobility),
2. The Internet of Services (intelligent networks and logistics),
3. Data Internet (intelligent buildings and apartments),
4. People's Internet (social and business networks).

All of the above-mentioned areas develop on the basis of widely understood IT solutions (hardware, software, automation, robotics, internet or broadly understood cloud computing). It is striking that the majority of the respondents in the further part of the research pointed at the areas particularly vulnerable to cybercrime as the most important sources of threats related to the development of logistics.

Table 4. The answers to the question concerning threats related to previously defined areas of logistics development.

Threat / Logistics	Value [%]
Hacker attacks	46
Data loss	19
Data theft	13
System failure	12
Solution implementing cost	7
Others	3

The conversations with the respondents during the research indicated their awareness of the risks that accompany IT solutions. Issues of software imperfections and security vulnerabilities will be discussed further in this study.

Proceeding to the part of the research conducted on the group declaring interest in transport, the results of the survey indicate that in this area the respondents clearly emphasize the need to apply IT solutions more and more often also in the case of transport services. The results obtained from the surveys carried out are presented in the table below.

Table 5. The answers to the question concerning important directions of transport development.

Innovation area / Transport	Value [%]
Safety in transport	33
Vehicle monitoring / parameters / eco driving	19
Use of modern means of transport	17
Financing of means of transport	13
Regulation change	12
Others	6

Nearly 70% of the answers to the question: Which of the solutions introduced in transport had the greatest impact on increasing innovativeness of this industry; pointed to those solutions in which the IT industry has the largest share.

The first three items were often defined by the respondents as security systems or driver support systems installed in lorries. Intelligent autonomous or semi-autonomous vehicles were mentioned many times which by replacing drivers in many activities would significantly improve the safety and economy of transport. The interest in this type of solution corresponds to the growing number of offers that are presented by vehicle manufacturers. Many of them have almost ready solutions that could be introduced into everyday operation were it not for, for example, legislative problems, specifying matters related to liability for possible traffic incidents, if a vehicle moves with the system releasing a driver from the obligation to drive or completely eliminates the requirement for a driver to be present while a vehicle is moving. Another solution that the respondents paid particular attention to were systems that allow for continuous monitoring and controlling of a vehicle as well as its movement parameters.

Analysing the answers to the question: What threats do the respondents see in connection with the introduction of modern solutions in transport; on the first place (almost half of the responses) was a threat related to the safety of drivers and the load. The results are shown below.

Table 6. The answers of the respondents concerning the threats associated with introducing innovations in transport.

Threat / Transport	Value [%]
Accident / driver and load	46
Costs	17
Hacker attack	15
Theft	10
Lack of information	7
Other	5

In this situation, it is hard not to notice that the majority of the respondents see the greatest threats related to well-known everyday life situations; with which most employees who work in the transport industry struggle every day. Only on the third and fourth place one can note those that can be combined with solutions related to high technologies.

4. OPPORTUNITIES

As mentioned above in this publication, the participants of the survey were mostly employees with many years of experience in the TFL industry, with extensive experience and knowledge. Many of them were former students of the International University of Logistics and Transport in Wrocław, who currently hold both operational and managerial positions in many enterprises in Poland. They systematically broaden their knowledge trying to reach information that sets the framework for the development of TFL in the perspective of not only current times but also the future.

Most of the interviewees are aware of the requirements set for the industry for the coming decades. They expect that solutions implemented in neighbouring countries, especially Germany, will also soon be implemented in Poland.

What can be expected? One of the solutions that will certainly start to be introduced to our area is the automation and robotization of production processes, and thus broadly understood logistics. The fourth industrial revolution will affect all global economies and also the Polish economy and logistics industry.

A lot of the investment in that field has been made in Poland for many years. The largest scale of investment in Poland is connected with the moment of its entry into the structures of the European Union and later into the Schengen Area. Then in many popular locations such as the largest transport hubs situated in the vicinity of: central Poland (Łódź / Stryków), Warsaw, Poznań, Wrocław, Kraków, Tricity or Upper Silesia, industrial sites and warehouse facilities related to the investments of Western companies were created. These investments need to be modernized to apply innovative solutions.

Mr. Jens Ocksen's statement, the president of Volkswagen Poznań, made in the portal wnp.pl confirms these needs [10]. He mentions that the Volkswagen plant in Antoninek will experience a technological leap ... because some of the

installations are devices from 2003 (they have been operating for 15 years). It's time for Industry 4.0.

In many cases, the process of automation and implementation of the Industry 4.0 solutions is a necessity because of the problems with finding the right amount of qualified employees who could meet the demands made of them. The situation was commented by Mr. Morawiecki, Deputy Prime Minister, in his speech for Polish Radio24 [11]. He pointed to the fact that the effect of the situation on the labour market is greater automation, which in many cases is a kind of substitution for manual labour. "Today it is a very good moment for Polish entrepreneurs, as unemployment is at such a low level, to show a natural inclination to replace work with automation, robotization". Nowadays a lot of companies have problems with shortages of staff.

The above information sounds optimistic also in the context of the growing attractiveness of Poland as a potential location of warehouse and logistics centres [12]. It is confirmed by a report of Prologis company, one of the largest developers offering storage space. Due to the fact that in many locations there is evidence of undermanning, it is expected that the future investments will be designed taking into account technologically advanced solutions.

5. THREATS

Paraphrasing the saying that each action generates a reaction, one can say that every innovation generates a threat connected with it. During the research, particular attention was paid to the fact that the threats indicated or defined by the respondents should correspond to the areas previously indicated as areas of innovation. Thus, the study answered the question of what the respondents were really afraid of. In both surveys, on hazards in logistics (78%) and in transport (61%), a very large number of the responses concerned areas in which IT solutions are the driving force behind innovations.

The answers showed that the respondents see the problems the IT industry currently has and they transfer their experiences to the limitations that new solutions may face in the future. Just to mention spectacular system failures or programming errors publicized by the media (e.g. Agency Routers) where world transport giants, such as Moller-Maerski [13] - one of the world's largest shipowners, fell victims of cyber-attacks. It is estimated that as the result of the hacker attack

that took place in June this year, this global giant lost between 200 and 300 million dollars [14]. This situation shows that for criminals specializing in hacker attacks, a completely new area appears, which in the future due to an increasing number of implementations of various types of software, autonomous devices (from vehicles, drones to powerful robot-ship) or computer controlled machines, will become a dream field for them. Who can guarantee that in the future there will be no theft of goods involving taking control over the vehicle control system and changing the vehicle destination while it will be driven by a special system and not by a human? Who will be responsible for this, who will pay possible compensation and will it be qualified by insurance companies as a seizure of property? Going further, a theft of a vehicle with goods can be viewed as a minor problem than, for example, breaking into the vehicle's control system, taking control over it and using a powerful truck for terrorist attacks that have taken place several times this year. Will security systems be immune to this type of criminal activity?

The second threat that arises in the responses is the problem with data loss or lack of access to data. At present, advanced solutions are appearing to solve these problems, for example through special copying systems (disk arrays, data duplication systems, cloud computing - where data is written in parallel on many carriers). The problem, however, is that this data can leak or be stolen. Press releases inform about such situations in cases of powerful banks or mobile network operators. In some circumstances thieves trade the stolen data by putting it on sale or demanding an entity to pay a ransom in exchange for not disseminating the information.

A lot of IT industry experts discuss the causes of these types of threats. The publication abundance on this issue shows its popularity (more and more companies allocate powerful funds for computer security) and its reality.

Specialists define the reasons for the emergence of security threats very differently. They can be a result of an intentional action or completely accidental. They may result from the user's unawareness or naivety, or they may be motivated by a desire for profit, applause or retaliation. They can come from outside the system or from the inside.

We distinguish the following threats [15]:

- burglary into a computer system,
- unauthorized obtaining of information,

- destruction of data and programmes,
- sabotage (work paralysis) of the system,
- software piracy, software theft,
- computer fraud and computer counterfeiting,
- computer espionage.

IT specialists point out that very often the increase in the number of dangers takes place simultaneously with the increase in the number of implemented solutions introduced in a specific industry. With the increasing number of opportunities, the number of attacks increases. There are opinions that the best solution would be to cut off a given system, operating for example in a terminal, enterprise or warehouse from Internet connections, making it completely hermetic, but the assumptions of ECONOMY 4.0 strategy almost force full symbiosis between different devices, solutions or software using the Internet, so by definition, this is irreconcilable.

6. SUMMARY

Trying to present the issue of the opportunities and threats connected with the current, fourth industrial revolution, it should be noted that the present solutions are just the beginning of what we can expect in the future. Many companies are now working on modern technologies with which we will have to deal in the near future and they claim that the technologies are practically ready, but their implementation is postponed until it is certain that these ideas will not cause additional threats to the environment. It does not only depend on the companies that prepare these improvements. To a large extent it also depends on the legal framework and the relevant regulations that impose the obligation to thoroughly investigate the impact on the environment.

In many countries, legal systems do not allow for experimentation on "a living organism", meaning a given area of the economy, in an imprudent way threatening the safety of users. Before a solution is approved for regular use, special certification and testing procedures must be performed. Very often companies trying to introduce their inventions to the market complain about the prolixity of these processes. Inventors argue that clerical bureaucracy is often a fundamental factor delaying implementation of inventions.

The work on security measures designed to protect users from negative impacts continues parallel to the design of the systems themselves.

For many companies designing safety measures to protect new technologies against attacks or failures is the main direction of their development. Programming and hardware companies create special teams of employees whose work focuses only on searching for solutions. Often, the results of work are the effect of joining teams from various industries, different countries or specializations. Such cooperation is also visible between industries, offices and branches of education.

Favourable assumptions about the role of modern technologies to connect devices, robots and people into one wonderful and efficient system should not override those features of mankind that

REFERENCES

- [1] IATA – International Air Transport Association - a global organization established in 1945, currently associating 275 air carriers and 400 strategic partners. The organization has its headquarters in Geneva and Montreal. (author's footnote on the basis of data contained on the official IATA website): www.iata.org, downloaded 20th October 2017).
- [2] ICAO – International Civil Aviation Organization - an organization established in 1944 and acting as a UN body responsible for developing regulations regarding air traffic safety (author's footnote on the basis of data contained on the official website ICAO): www.icao.int, downloaded 20th October 2017).
- [3] IMO – International Maritime Organisation - an organization established in 1959 as a UN consultative body, a global organization based in London responsible for solving all matters related to the safety of maritime transport (author's footnote on the basis of data contained on the official website: www.imo.org, downloaded 20th October 2017).
- [4] Janasz W., Kozioł K.: *Determinanty działalności innowacyjnej przedsiębiorstw*. PWE, Warszawa 2007.
- [5] Niedzielski P., Rychlik K.: *Innowacje i Kreatywność*. Uniwersytet Szczeciński, Szczecin 2006.
- [6] Schumpeter J. A.: *Teoria rozwoju gospodarczego*. PWN, Warszawa 1960.
- [7] The author's elaboration based on The World Bank, www.worldbank.org, (downloaded 20th October 2017).
- [8] The author's elaboration based on The World Bank, www.worldbank.org, (downloaded 20th October 2017).
- [9] Herman M, Pantek T., Otto B.: *Design Principles for Industries 4.0 Scenarios*, (downloaded 20th October 2017).

- [10] W stronę automatyzacji. Volkswagen Poznań unowocześnia produkcję, <http://www.wnp.pl/wiadomosci/309259.html> (downloaded 20th October 2017).
- [11] Morawiecki M., Automatyzacja odpowiedzią na brak rąk do pracy, www.polskieradio.pl (streamed on 18th September 2017).
- [12] Najbardziej pożądane lokalizacje logistyczne w Europie, Raport firmy Prologis, <https://log4.pl/najbardziej-pozadane-lokalizacje-logistyczne-w-europie,379,15537.htm> (downloaded 20th October 2017).
- [13] Agencja Reuters, Global shipping feels fallout from Maersk cyber attack, <https://www.reuters.com/article/us-cyber-attack-maersk/global-shipping-feels-fallout-from-maersk-cyber-attack-idUSKBN19K2LE> (downloaded 20th October 2017).
- [14] Financial Times, Moller-Maersk puts cost of cyber attack at up to \$300m, <https://www.ft.com/content/a44ede7c-825f-11e7-a4ce-15b2513cb3ff>, (downloaded 20th October 2017).
- [15] Bezpieczeństwo systemów komputerowych, <http://wazniak.mimuw.edu.pl>, (downloaded 20th October 2017).

Date submitted: 2018-10-31

Date accepted for publishing: 2018-10-31

Robert Mendruń
The International University of Logistics and
Transport in Wrocław, Poland
robert@mendrun.pl

Iwona Bożydaj-Jankowska
University of Economics in Wrocław, Poland
iwona.bozydaj-jankowska@ue.wroc.pl

