THE IMPACT OF LOGISTICS SECTOR ON SUSTAINABLE DEVELOPMENT

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Abstract In the context of global economy, logistics activities are necessary for ensuring the global competitiveness of other sectors and comprehensive development of the country. In the recent years, the concept of sustainable development is changing the meaning of economic growth. Taking into account the meaning of logistics and principles of sustainable development, the main aim of the article is to assess the impact of the logistics sector on sustainable development. In order to achieve this aim, theoretical concepts of sustainable development, logistics and its relationship are revealed , as well as key macroeconomic indicators and indices are identified and applied when evaluating the impact of logistics sector on sustainable development. The findings indicate that in the context of European Union countries, logistics sectors related with transport and IT factors significantly influence different indices of sustainable development.

Key words: *logistics sector, sustainable development, impact evaluation.*

Introduction

Relevance of the article

The development of the global economy and increasing competition have given the strategic importance to the sector of logistics. Due to growing international trade volumes and the increasing distance between production and consumption points all sectors become dependent on logistics (Sezer, & Abasiz, 2017). Depending on the country, the logistics industry accounts for an average of about 5 percent of Gross Domestic Product (GDP) in the country and varies from 2 to 15 percent in different countries (Gani, 2017). All this suggests that the logistics sector has a direct and indirect impact on the country's economy through job creation, income and investment growth. Moreover, in the context of the 21st century, not only economic growth, but also sustainable development is emphasized.

Level of problem investigation

Despite the importance of the logistics sector, D'Aleo, & Sergi (2017), Hayaloglu (2015), Sezer, & Abasiz (2017), Sharipbekova, & Raimbekov (2018) admit that there is still a lack of scientific literature and research on the importance of the logistics sector for sustainable development. The literature review indicates that most of these studies are based on the use of qualitative methods, while quantitative research on the subject is limited (Hayaloglu, 2015).

Scientific problem

The impact of the logistics sector on sustainable development has not been sufficiently analyzed and interpreted. Most research has focused on the impact of transport, ignoring logistics as a whole. It is therefore necessary to assess the impact of the logistics sector on sustainable development in the broad sense.

Object of the article the impact of logistics sector on sustainable development

Aim of the article to carry out the assessment of logistics sector on sustainable development.

***Objectives of the article*:**

4. To investigate theoretical concept of sustainable economic development and logistics sector.
5. To analyze the relationship between logistics sector and sustainable development and its indicators.
6. To evaluate the impact of the logistics sector on sustainable development.

Methods of the article: research literature analysis and synthesis, correlational analysis, exploratory factor analysis, multiple linear regression analysis.

1. Theoretical concept of sustainable development and logistics sector

The concept of sustainable development is related to the concept of economic development. From a narrow point of view, economic development can be seen as the progress of a geographical unit (country, region or locality), usually identified with economic growth (Candemir, & Celebi, 2017).

However, this approach is open to criticism because the mere economic growth is not enough to develop the economy (Shaffer, Deller, & Marcouiller, 2006). In a broad sense, one can safely say that sustainable development is more than economic growth - it must be perceived as a structural change encompassing economic sectors, institutions, social, cultural and environmental well-being.

The theoretical analysis confirms that it is not possible to identify economic growth with sustainable development, therefore, Table 1 compares these two concepts, highlighting the fundamental differences between the two concepts.

Table 1

Comparison of economic growth and sustainable economic development

Economic growth	Sustainable development
Defined as output growth	There is no unified definition
Mostly short-term process	Exceptionally long-term process
Has a strong theoretical background	Lack of theoretical background
Quantitatively measurable	Qualitative process, difficult to measure
Includes only economic aspects	Includes not only economic, but also social, cultural, environmental, and political aspects
Social problems are solved only through economic decisions	The aim is to solve social and environmental problems with comprehensive solutions
May have a negative impact on society and the environment	Negative effect is minimal

Source: based on Feldman, Hadjimichael, Lanahan, & Kemeny (2016); Salimath, & Chandna (2018)

The analysis of the Table 1 shows that economic growth is fundamentally different from sustainable development. Economic growth has a solid theoretical background and is easily quantifiable as an increase in total output. Meanwhile, sustainable development is a more qualitative process that is difficult to measure and evaluate, it lacks a unified definition and theoretical background. While economic growth can be achieved without sustainable development, such growth is short-lived. Meanwhile, sustainable development creates the conditions for long-term economic growth. One of the most important differences is that despite growth in per capita income, economic growth can have a negative impact on welfare and quality of life. Meanwhile, sustainable development is associated with positive changes in the society and the environment, with negative impacts being minimal. Moreover, economic growth is relatedexclusively to economic change, while sustainable development involves structural change, social and environmental prosperity, and a favorable environment for future generations.

While most scientists agree that the core logistics activity is transportation (Candemir, & Celebi, 2017; Hayaloglu, 2015; Sezer, & Abasiz, 2017), more comprehensive analysis have become more popular in recent years, with logistics as a wide range of services, including information flow, the distribution of raw materials from delivery to production to the final consumer market (Hayaloglu, 2015; Sezer, & Abasiz, 2017). Similarly, the logistics can be defined as the use of existing infrastructure on the way from raw materials to end-point in planning and controlling activities, both in terms of cost reduction and quality (Sezer, & Abasiz, 2017). This concept reveals not only the movement of raw materials and information, but also the essential goals of cost reduction and high quality service. Hayaloglu (2015), defining the concept of logistics, not only defines logistics as large-scale activities involving the allocation of resources from production to final consumption, but also emphasizes the importance of information movement.

Logistics involves both physically tangible or perceived activities and intangible activities, related to the provision of services or even strategic decision-making. In order to evaluate the different components of the logistics sector, three key groups of logistics activities can be distinguished: transport, involving various modes of transport; logistics infrastructure activities focused on the use of existing infrastructure; and logistics services that reflect intangible activities, most often associated with the use of human resources.

Although the sustainable development and the logistics sector may seem to be unrelated, the logistics sector is perhaps one of the most important driving forces of economic development because

of its importance for the functioning of the economy. In addition, the importance of logistics in the context of sustainable development is crucial, not only for economic but also for social and environmental well-being.

2. The relationship between logistics and sustainable development and it's indicators

The relationship between energy consumption, CO2 emissions and economic growth is intensively analyzed in scientific literature. The greater part of the studies show that rapid economic growth causes increased energy consumption and CO2 emissions (Danlami, Aliyu, & Danmaraya, 2019). Mangiaracina, Marchet, Perotti, & Tumino (2015) argues that transport and thus all logistics are difficult to reconcile with sustainability ideas. This is especially true for the last-mile delivery when the goods are delivered directly to customers' homes. Depending on various factors, the cost of such transportation can range from 13 to 75 percent of the entire supply chain costs (Buldeo Rai, Verlinde, & Macharis, 2018). Although home delivery is particularly attractive to consumers and increases their level of satisfaction, this logistics activity is incompatible with sustainable development, both for economic and environmental reasons, because it is expensive, inefficient and leads to higher emissions. This is fundamentally contrary to the concept of sustainable development.

Analyzing the contribution of logistics to more sustainable development, there are also many positive examples. The decarbonisation initiative in freight transport - moving to more environmentally friendly vehicles, consolidating transport (merging), and focus on reduction of energy consumption is becoming more and more popular. Responsible management of logistics operations is an important goal in recent days, for example, to reduce global CO2 emissions by 8 percent (Tacken, Sanchez Rodrigues, & Mason, 2014). In the case of the last mile delivery, efforts are made to make the delivery more efficient through the introduction of longer delivery terms, the use of alternative delivery addresses (collection points, post offices). Recent trends show that in the business-to-consumer sector, pick-up at stationary pick-up points or shops is gaining popularity. Alternatives to trucks are being sought to reduce the negative impact of transport in cities. Some logistics service providers are experimenting with more sustainable vehicles, such as freight bikes or electric cars, which are given some preferences in cities (such as additional transport lanes). It enables not only to meet the environmental requirements but also make the transportation activities more efficient (Buldeo Rai et al., 2018). Although the last mile of transportation is just one of many logistics activities, it is a critical part of the supply chain - without this activity, the whole complex of logistics services becomes meaningless.

With the growing popularity of sustainable development discussions, logistics service providers, which are part of the supply chain, must respond to the growing demand for sustainability. Green logistics literature draws attention to the fact that logistics service providers should focus on processes to optimize the environmental point of view, for example, by reducing transport CO2 emissions (Gruchmann, & Seuring, 2018). It is noticeable that in logistics it is necessary to develop social responsibility strategies through improvement of working conditions, satisfaction of public interests - ensuring of public transport, noise reduction (Yawar, & Seuring, 2017). According to Maparu, & Mazumder (2017) effective transport planning solutions often have a significant impact on sustainable development through government and consumer spending, employability, resource use, productivity, local environmental quality, availability of services and quality of life.

The impact of the logistics sector or its individual components on growth or development is analyzed by Candemir, & Celebi (2017), Celebi, Civelek, & Cemberci (2015), Chen, & Novy (2011), D'Aleo, & Sergi (2017), Ekici, Kabak, & Ulengin (2016), Hayaloglu (2015), Maparu, & Mazumder (2017), Sezer, & Abasiz (2017), Sharipbekova, & Raimbekov (2018). Authors rely on different methods and use various indicators of logistics and economic development. It should be noted that the vast majority of authors use quantitative macroeconomic indicators, derivative indices or thereof combinations for such research.

Scientists evaluating the impact of the logistics sector on the economic growth or sustainable development often use macroeconomic indicators that reflect the situation in specific countries. The

most popular logistics sector indicators used to assess the impact of the logistics sector are presented in Table 2.

Table 2

Logistics sector indicators

Authors	Logistics indicators
Hayaloglu (2015)	Investment in inland transport infrastructure, millions Freight transportation by road, million ton-km Freight transportation by rail, million ton-km Air freight transportation, million ton-km Number of fixed telephone lines per 100 people Number of mobile phones per 100 people Number of Internet users per 100 people
Maparu & Mazumder (2017)	Total length of roads, km Length of paved roads, km Length of highways, km Rail length, km Number of air passengers, million Air freight, million ton-km Cargo loaded in ports, thousand. t. Expenditure in the transport and telecommunications sectors, million
Sezer & Abasiz (2017)	Freight transportation by rail, million ton-km Air freight transportation, million ton-km Investments in the transport sector (mln. USD). Length of highways, km Rail length, km Number of Internet users per 100 people Investments in telecommunications (mln. USD). Number of mobile phones per 100 people Number of fixed telephone lines per 100 people
Sharipbekova & Raimbekov (2018)	Freight transportation by rail, million ton-km Air freight transportation, million ton-km Number of mobile phones per 100 people Number of fixed telephone lines per 100 people People who use the Internet, percent of total population Freight transportation by road, million ton-km

As may be seen in Table 2, indicators such as investments in transport infrastructure and telecommunications sector, freight transport by roads and rail, air freight tarnsportation, length of roads and highways, distribution and use of telecommunications: number of Internet users, number of fixed telephone lines and number of mobile phone users are the most commonly used indicators to reflect the logistics sector.

When analyzing the indicators used by different authors to assess economic development, it should be noted that the main drawback of previous studies is the focus on economic aspects of development, while social and environmental dimensions are not included in such assessment. However, in the context of sustainable development it is necessary to consider the compatibility of economic prosperity with social and environmental aspects and to include indicators representing these dimensions in the assessment accordingly. It is noteworthy that the use of indices is particularly useful in analyzing the impact of the logistics sector on sustainable development, as sustainable development is complex concept that combine many individual indicators, the individual examination of which is a complex, often inefficient and time consuming process**.**

Indexes that reflect sustainable development are very numerous and their use in research is diversified. The core indices used in studies are presented in Fig. 1.

Source: based on Morse (2015).

Fig. 1 Sustainable development indices

As we may note in Fig. 1, some indices are focused on specific development aspects such as economic prosperity (eg Index of Economic Freedom / IEF), social progress (eg Human Development Index / HDI) or environment (eg Ecological Footprint / EF). Meanwhile, other indices cover a broader concept of development and assess different dimensions of sustainable development (eg Global Competitiveness Index / GCI; Sustainable Development Goals Index / SDGI). Some indices are created using similar or analogous indicators so the empirical research of sustainable economic development is usually limited to the use of one or more indices.

Therefore, not only the theoretical concepts of logistics and sustainable development have been revealed, but also the macroeconomic indicators and indices have been identified to measure the impact of the logistics sector on sustainable development. These indicators and indices are then used in the empirical study.

3. The evaluation of the impact of logistics sector on sustainable development

Research methods

Aim of the research – to assess the impact of the logistics sector on sustainable development.

Objectives of the research:

1. To define what groups of indicators (factors) can be grouped into logistics sector variables.
2. To assess the impact of selected logistics sector reflecting factors on sustainable development indices.
3. To compile forecasting models of sustainable development indexes according to the factors reflecting the logistics sector.

Research methods. Correlation analysis, exploratory factor analysis, multiple linear regression.

The research data analysis and the discussion of the results.

In the first stage of the research, exploratory factor analysis was performed using the 2017 macroeconomic indicators of the logistics sector in 24 EU countries, which combined the logistics sector variables with unobservable latencies (4 EU countries - Cyprus, Malta, Luxembourg and Belgium are not analyzed due to lack of data). Then, multivariate linear regression analysis was performed and forecasting models for sustainable development indices were developed. This was done using unobservable latent factors and indices reflecting sustainable development. Exploratory factor analyzes and multiple linear regression assumptions were tested. It was found, that the data meet the requirements.

During the exploratory factor analysis, the variables reflecting logistics sector were separated into factors by the principal components method in order to reduce their number and to avoid correlation between them. It was found that it is expedient to exclude two 2 factors, and for easier interpretation orthogonal Varimax rotation was performed. F1 was found to be significantly related to the variables AV1, AV2, AV3, AU1, AU2, AU3, AU4, G1, G2, G3, EV, which represent transportation, transport infrastructure and associated energy costs. Therefore, F1 is called "Transport". Factor F2 is statistically

significantly related to variables IT1, IT2, IT3, IT4, which reflect the use of information and communication technologies. Therefore, F2 is named "IT". The isolated factors with their constituent indices are presented in Table 3.

Table 3

Assigning variables to factors

Variable		F1 score	Variable		F2 score
AV1	Number of international air passengers carried in the EU	0,821	IT1	People who use the Internet, percent of total population	0,873
AV2	Number of international air passengers carried outside the EU	0,910	IT2	People who buy goods and services online from other EU countries, percent of total population	0,887
AV3	Air freight and mail, t	0,905	IT3	Part of companies receiving online orders, percent	0,832
AU1	Length of highways, km	0,821	IT4	Part of the population with basic and advanced knowledge of the ICT, percent	0,894
AU2	Number of passenger cars	0,989			
AU3	Number of trucks over 3,5 t	0,750			
AU4	Freight transportation by road, million ton-km	0,890			
G1	Rail length, km	0,961			
G2	Number of passengers carried by train	0,928	-	-	-
G3	Freight transportation by rail, million ton-km	0,763			
EV	Energy used by the transport sector, thous. t of oil equivalents	0,978			

Moreover, the regression analysis of how the factors of the logistics sector - transport and IT - influence the sustainable development expressed in indices. The following indices identified in the theoretical analysis that reflect the dimensions of sustainable development were chosen for the analysis – Sustainable Development Goals Index (SDGI), Global Competitiveness Index (GCI), Environmental Performance Index (EPI), Human Development Index (HDI) and Corruption Perception Index (CPI). Two indices that were identified as reflecting sustainable development – Index of Economic Freedom (IEF) and Ecological Footprint (EF) - were excluded from the analysis due to lack of data. The forecasting models and their accuracy are presented in Table 4.

Table 4

The forecasting models of sustainable development indicesa

Nr.	Model	R^2
1.	SDGI = 77,476 + 3,563 IT	0,7033
2.	GCI = 4,827 + 0,211 Transport + 0,4 IT	0,8109
3.	EPI = 72,971 + 2,519 Transport + 4,787 IT	0,6592
4.	HDI = 0,882 + 0,013 Transport + 0,034 IT	0,8471
5.	CPI = 64,857 + 12,570 IT	0,777

The obtained linear regression results showed that five different indices reflecting sustainable development - SDGI, GCI, EPI, HDI, CPI - have a positive effect on indicators reflecting ICT as the part of logistics. Meanwhile, transport variables, which include infrastructure, passenger and freight volumes, and energy consumed by transport, have a statistically significant effect only on GCI, EPI and HDI. This suggests that, in the context of sustainable development, transport growth is less significant than IT.

Conclusions

1. Sustainable development is a long-term, complex and continuous development process, which is determined by a combination of economic, social and environmental factors. The logistics sector ensures the efficient functioning of the economy, creates a life-friendly infrastructure, but the increasing scope of activities causes environmental problems and damages the quality of life. Therefore, the essential task of the logistics sector in the context of sustainable development is to

contribute to the development of countries without adverse effects on the socio-cultural and natural environment.

2. While there is growing interest in sustainable development within the scientific community, the impact of logistics on economic growth, but not sustainable development, is often analyzed. The negative environmental and societal impacts of the logistics sector encourage the talk of sustainable economic development as the basis for sustainable development and development of countries. The analysis of macroeconomic indicators allows to reveal the links between the logistics sector and sustainable economic development, while the use of derivative indices allows for complex analysis.
3. According to the results,, transport and IT factors reflecting the logistics sector in the context of the European Union countries significantly influence different indices of sustainable development. However, predictive models from multiple regression analysis have shown that IT has a stronger impact on sustainable development indices than transport.

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