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Logistics Development in European Countries: The Case of Poland

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Abstract:

Purpose: *The purpose of the article is to show the diversity of logistics development in European countries at the national and regional level, taking into account the countries of Western, Central and Eastern Europe. The focus is on the development of logistics in Poland, a country with a special location in Europe between Germany, the leader in European and global logistics, and Russia.*
Design/Methodology/Approach: *Research includes changes in the volume of freight transport by air, rail, road and sea in 33 countries in 2010-2018. Spatiotemporal analysis of statistical data with the use of GIS (Geographic Information Systems) and ArcMap 10.5 is proposed.*
Findings: *Logistics in Europe is strongly diversified in national and regional terms. In most countries, logistics developed for all modes of transport during the period considered. The development of the logistics system in Poland mainly involved road, rail and sea transport. Air transport of goods increased to a lesser extent. The integration process of Central and Eastern European logistics with German logistics is visible.*
Practical Implications: *The contribution of the research is to show the general interrelationships between logistics policy and initiatives at the national level and changes in the volume of freight transport across the most important transport branches.*
Originality/Value: *Use of Geographic Information Systems (GIS) to represent the changes occurring in logistics in Europe. Identification of countries and regions with different logistics development models and paths.*

Keywords: *Logistics, transport, NUTS1, Europe, Poland.*

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1. Introduction

Logistics development is characterized by significant spatial diversity on a global scale. There are regions like Europe and countries like the US in which the level of logistics development is high, and regions and countries where the logistic practices are at a very low level. These differences result from the country and region's level of economic development, which translates into the intensity of international exchange and the need to employ advanced information technologies that are used in logistics solutions (Gracht and Darkow, 2013). National and regional diversification of logistics also results from the degree of development of transport infrastructure and its adaptation to the needs of the economy in the area of moving streams of goods for domestic needs as well as export and import. Logistics also depends on the structure of the economy and the development of the industrial and service sectors, which affects the specificity of supply chains.

Although phenomena such as corporate globalisation and internationalisation bring regions closer in terms of logistic practices and supply chain management, there are still differences in the aspects of supply and demand of the supply chain. The transfer of logistics knowledge at the institutional and business levels faces significant limitations despite the free movement of workforce employed in logistics and transport, as well as other, e.g. industrial and service sectors. In various cases, logistics operators functioning in an international environment continue to use solutions dedicated to customers in a given country or region, which confirms the impact of spatial conditions on logistics activities.

The development of European logistics is historically associated with the processes of European integration and the formation of European Union structures, as well as the division of Europe after World War II. The division into Western, Central and Eastern European countries led to the creation of a permanent border for the transfer of concepts and technologies used in logistics. Western European countries have adopted American experience and developed their own logistics solutions, and national borders have quickly become real barriers to the flow of goods within European space. The following research questions were formulated to show the development of logistics in Europe and Poland in this context:

- *What are the key factors influencing the development of logistics in Europe?*
- *What is the specificity of logistics in Poland?*
- *What changes occurred in transport in Europe in 2010-2018?*

We thereby also aim at developing the concept of logistics assessment based on the analysis of changes in transport in EU countries. Statistical data derived from Eurostat describing transport at the NUTS 1 level in 33 European countries were used as our main data source. The analysis employed Geographic Information Systems (GIS) using the ArcMap 10.5 software. This study provides analysed empirical evidence for the diversity of transport at a country level and encompasses

the entire European geographical area outside Turkey. The use of spatial analysis tools (GIS), which are not commonly implemented in transport research, creates a chance to learn about spatial dependencies related to individual modes of transport.

The study consists of 5 sections. Section 2 describes the theoretical background of the study and offers an in-depth discussion of the main trends in European logistics as well as factors affecting its development. Section 3 presents the methodology - the database used in the study and the methods applied in further analysis. Section 4 provides a detailed description of the results of the preliminary data analysis and spatial analysis of transport in Europe in the 2010-2018 period. Section 5 presents the conclusions and outlines further research directions.

2. Theoretical Background

2.1 Development Trends in European Logistics

The development of European logistics was strongly conditioned by the ongoing Cold War and military logistics concepts that were implemented in Western European countries as part of the NATO Pact and the Eastern Bloc. The conceptual basis of Communist Logistics drew on planning the links between military logistics and the national economy, including the use of civil resources, such as trade, industrial production, labour resources, and capital (Young, 2016; Sambracos and Ramfou, 2014). Once the Eastern Bloc collapsed and its countries departed from the central planning policy, some countries, like Poland, were incorporated into NATO structures. Military logistics in these countries was restructured and strategically reoriented, whereas civil logistics experienced intensive development.

Research into European logistics until the end of the 1980's was mainly carried out in Western Europe. Cooper (1991) conducted research on 54 companies located in Europe, using the division into consumer logistics and industrial logistics. The main areas of assessment that allowed to define logistics performance were logistics planning, inventory holding, use of logistics service suppliers, customer service, and price paid for logistics services. Research results revealed significant differences between performances of companies from different countries; however, they failed to explain the reasons behind these differences. It has also been proven that logistics efficiency varies significantly depending on the performance indicator that has been used, which confirms the diversity and specificity of national logistics.

Another subsequent vision of logistics development in Europe was based on the effects of the Single Market establishment in January 1, 1993 in the form of restructuring of production and logistics operations and their adaptation to the new European market (O'Sullivan, 1997). The survey of 300 international companies in Europe demonstrated that the most significant factors affecting the changes would be customer service, information technology, third party distribution, environmental issues, restructuring of logistics operations, transformation of national into European

market organisations, and the growing importance of logistics management in organisations. The importance of Central and Eastern Europe as a location for new production and logistics investments was also emphasized (Albekov *et al.,* 2017).

Skjoett-Larsen (2000) pointed out that the key forces of change in the logistics structure and strategy in Europe would be the removal of trade and transport barriers between EU countries, the opening of new markets in Eastern Europe, the acceptance of a single European currency, the development of information technology and fast communication systems and the emergence of pan-European logistics service providers. The most important carrier of changes would be the growing importance of logistics operators in Europe, especially in terms of integration of the supply chains of countries such as Poland, Hungary and Czech Republic into the supply chains of Western Europe. The basis for the integration of supply chains constitute small differences as regards technology and quality, but significant differences in terms of payroll costs. The special role of LSP's for the development of European logistics in research on a sample of 53 shippers in Belgium, Germany, the Netherlands, Sweden and the UK is also observed by (van Laarhoven, Berglund and Peters, 2000).

Bookbinder and Tan (2003) applied cluster analysis including 33 surveyed countries in three levels of logistic excellence. The adopted perspective of international logistics refers to the comparative analysis of logistic systems of countries, taking into account four general attributes i.e. infrastructure, performance, information systems and human resources. The first cluster, the most developed countries in terms of logistics practices, includes European countries such as Denmark, Finland, the Netherlands, Germany, Luxembourg, Austria, Sweden and Ireland, whereas the second cluster comprises Belgium, France, Spain, the UK, Portugal and Hungary. The third cluster includes Italy, Slovenia, Czechoslovakia, Greece, Poland and Russia.

A different approach to modelling and analysing logistics systems assumes that transport plays a special role in the system. Jacyna *et al.* (2010) presented the Logistics System of Poland in which they included variables such as road border crossings, rail border crossings, sea ports, inland river ports and airports. This approach assumes the special role of effective use of individual transport modes, which is in line with EU policy in the development of European logistics.

D'Aleo and Sergi (2017) state that the impact of the logistics sector on economic growth in the European Union is estimated at 10% of GDP. At the same time, they indicate that logistics encompasses 'freight transportation, warehousing, border clearance, payment systems, and increasingly many other functions outsourced by producers and merchants to dedicated service providers'. They emphasize the importance of infrastructure, including immaterial infrastructures like digital technologies, for the effectiveness of the national logistics system. The conceptual model used in the research includes examining the relationship between LPI

(Logistics Performance Index) and relevant factors from GCI (Global Competitiveness Index), which are grouped into three clusters 'Infrastructure', 'Human Factor' and 'Institutions'.

Logistics Performance Index (LPI), Agility Emerging Markets Logistics Index (AEMLI) and Global Competitiveness Index (GCI), in particular GCII subindex 'Infrastructure', are the most frequently used methodologies in logistics research. Attempts to improve existing methodologies are also worth noting. Beysenbaev and Dus (2020) proposed the Integrated Logistics Performance Index (ILPI). Application of this new index in the case of Germany results in the reduction of Germany's position as the leader according to LPI in 2018 by 3 places and moving Poland 10 places up to from position 27 to 17.

2.2 Specificity of Logistics in Poland

As Spillan, Vyas and Ziemnowicz (2004) state the transition from a centrally planned economy to a global market economy has greatly influenced Poland's share in global trade. The main factors shaping the competitive advantage in the area of Polish supply chain management include: government and government institutions, geographical location and physical infrastructure, economy, market and technology in logistics sector. Poland has a strategically important location, which is confirmed by the increase in the number of new logistics centres in Central Europe, although it is located between the two most important economies in the world, Germany and Russia.

A different approach to logistics research locating Poland in Central Europe involves including it in the Baltic Sea Region group of countries (Ojala, Kersten and Lorentz, 2013) together with Belarus, Denmark, Estonia, Finland, Northern Germany, Iceland, Latvia, Lithuania, Norway, Northwest Russia and Sweden. This approach only takes into account the northern part of Poland. Next to Germany, Finland and Norway, Poland is in the top four countries in this group with the largest expenditure on logistics, with the average expenditure of the Baltic Sea Region countries at 8.7% of GDP. The average for EU 29 is 7.1% of GDP. Conclusions from the Delphi method tests carried out in autumn 2012 indicate, among others, that the logistics sector in the Baltic Sea Region will play a greater role in the economy of the region. According to the results, greater consolidation of logistics and transport market is expected and road and rail transport infrastructure may be experiencing under-capacity by 2025.

The particular location of Poland in Europe within the Belt and Road Economies places it at the intersection of transport corridors, which means that this fact should be considered in logistics research in Poland (Ruta *et al.*, 2019). Taking into account the availability of maritime shipping services in the coastal corridor between China and Europe, Polish ports place themselves behind the ports of Germany, Holland and the UK (Novo-Corti and Gonzalez-Laxe, 2009). Estimated delivery times based on

GIS between China and Central and Eastern European countries such as Poland, Croatia, Estonia are on average over 30 days. Despite the fact that, in general, the impact of BRI transport projects is positive for all corridor economies, there are significant differences related to the distribution of benefits from participation in regional and global value chains. The smallest profits are obtained by Eastern European countries, and, in particular, by Poland which is experiencing a slight decline in exports because the new infrastructure reduces its competitiveness in relation to other economies.

World Bank's Services Trade Restrictiveness Index (STRI) for 2012 showing the level of services trade protectionism for corridor economies indicates that countries such as Poland, Armenia, Georgia and Lithuania have STRI's 14.3% below that of the United Kingdom, the least restrictive country in G7 (Grosso *et al.*, 2015). Poland is among the corridor economies with above-average access to shipping services. It is perceived as a bottleneck in relation to the insufficient capacity of European railways, including transhipment facilities, in terms of northern and southern routes connecting China and Europe. The improvement of Poland's situation in this area is reflected in EU initiatives and projects, such as RECORDIT, REORIENT or BELOGIC, which aim to improve the efficiency of rail transport (Wiegmans and Behdani, 2018).

Poland is an active participant in the Belt and Road Initiative and the New Euro-Asia Land Bridge among 55 countries that directly partake in the creation of common transport infrastructure (De Soyres, Mulabdic and Ruta, 2019). Results of quantitative research using GIS show that BRI transport infrastructure projects increase GDP for BRI economies by up to 3.35 percent.

Similarly to entire Europe, logistics development in Poland includes a rise in logistics outsourcing and an increased activity of international logistics operators (Wilding and Juriado, 2004; Lichocik and Sadowski, 2013; Magda, 2015). As Marilyn (2002) arguments based on research results relating to the expansion of UK-based LSP's, European logistics sector is managed on the basis of a country-by-country framework with the support of major SBU's providing single-country logistics. At the same time, strategies based on pan-European and multidomestic organisations are important in terms of the convergence of logistics structures in Europe. As indicated by research results covering 26 LSP's operating in Europe, the principal role of logistics operators is to increase the degree of integration of supply chains (Fabbe-Costes, Jahre and Roussat, 2009). Most of the major LSP's in Poland have their roots in Western European countries and there has been no diffusion of Polish logistics solutions into Western European markets, although this process is in its initial period of development.

Polish economy is strongly associated with other countries. In the area of transport and trade, this is particularly reflected in its relations with German economy and the Czech Republic. Globalisation and deregulation of the European economic space,

including transport, has contributed to the significant development of enterprises in the road transport sector in Poland, which plays an important role in international logistics in Europe (Akyelken and Keller, 2014).

3. Methodology

The analyses of logistics in Europe were performed based on statistical data available at the European Statistical Office (the source of data was transport database). In order to show the most complete picture of logistics in Europe, in addition to the European Union countries (Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom), the analyses also included Iceland, Montenegro, Northern Macedonia, Norway, Switzerland - i.e. 33 European countries in total. The main goal of the research was to analyse the diversity of logistics in Europe at the country level.

Therefore, the most appropriate way to conduct the analysis appeared doing it at the NUTS 1 level which represents the basic regions for the application of transport and logistics policies. Nevertheless, due to the lack of statistical data on transport at the NUTS 1 level for some countries (the largest data gaps occurred in the case of Malta, Cyprus, Liechtenstein, Iceland, Serbia, Montenegro, Bosnia and Herzegovina), the analyses were carried out for NUTS 1. The analysed variables describing transport were:

- A: Air transport of goods;
- RA: Rail transport of goods;
- RO: Summary of annual road transport of goods;
- M: Maritime transport of goods.

Statistical data were collected for the years 2010-2018. Unfortunately, the database had certain deficiencies, especially in the case of Slovakia, where information for NUTS 1 about air transport was available from 2014, and Belgium for which information about rail transport was available until 2012.

In order to characterize the spatial structure of logistics in European region and changes occurring over time, the values of variables were marked on the maps and the indicator defining the direction of changes was calculated. Normalized values of variables included in the study were used for calculations. The normalized indicator determines the level of change of the phenomenon over time.

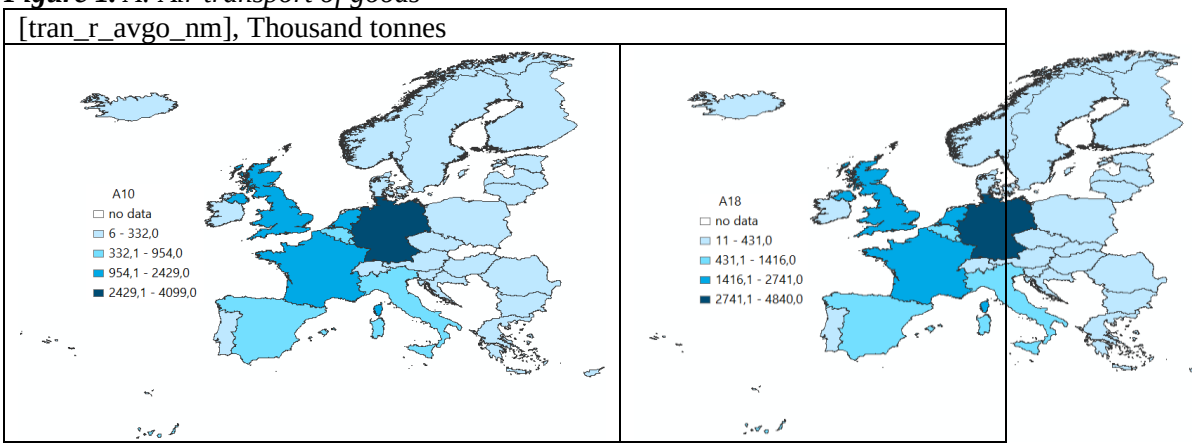
4. Findings

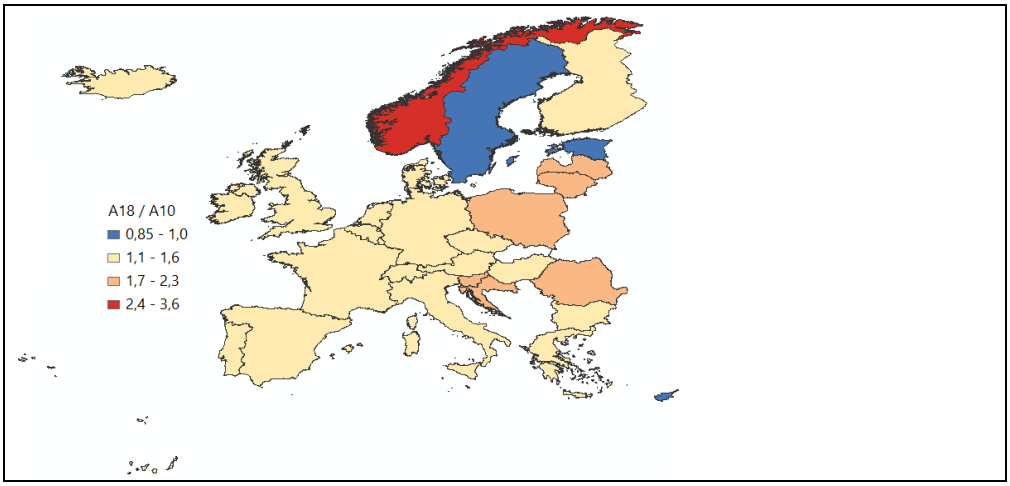
Figures 1-4 present values of the analysed variables in selected years (2010, 2018) as well as the normalized change indicator. It should be highlighted that, for the clarity

of maps, some islands belonging to Spain, Portugal and France were removed from obtained results' visualisations, but they were not excluded from analyses. Figure 1 presents statistical data and preliminary analyses for variable A. The maps clearly show the considerable spatial diversity of the variable in Europe. Germany has the most developed air freight transport, followed by France, the Netherlands and the UK, which is associated with high requirements for airport infrastructure and aviation logistics. There is a clear division in Europe in terms of the volume of goods moved by air transport.

Central and Eastern European countries (Poland, Czech Republic, Slovakia, Hungary, Lithuania, Latvia, Estonia, Bulgaria and Romania) do not commonly use air transport to transport goods. This is due to the limited participation of the countries of this region in the creation of the global supply chain and global value chain in which air transport is used to move highly processed goods. The highest value of the indicator showing the level of changes in air transport of goods was obtained for Norway where it falls within the range of 2.4-3.6. Several countries of Central and Eastern Europe (Poland, Lithuania, Latvia, Slovenia, Croatia and Romania) also recorded a significant increase in the indicator in the range of 1.7-2.3. A slight decrease in the amount of goods moved by air occurred in Sweden and Estonia.

Figure 1. *A: Air transport of goods*

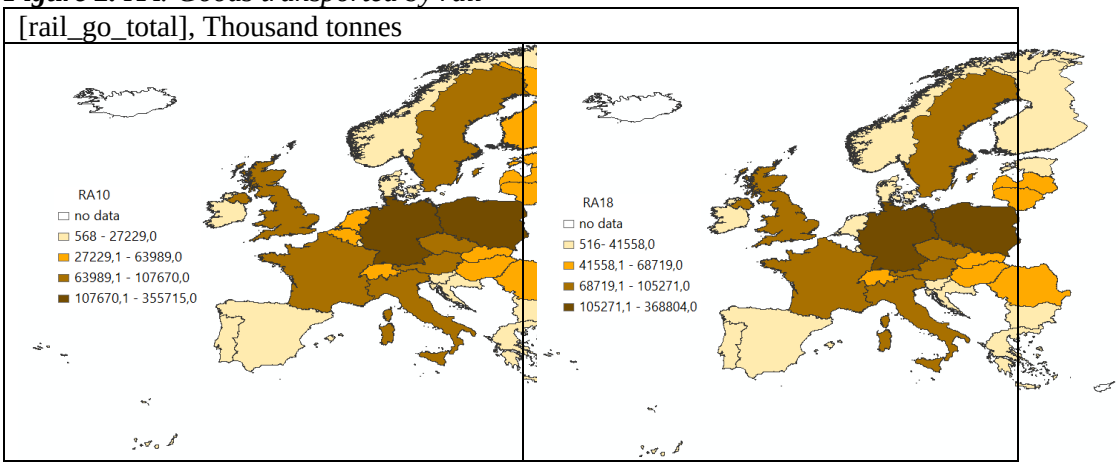


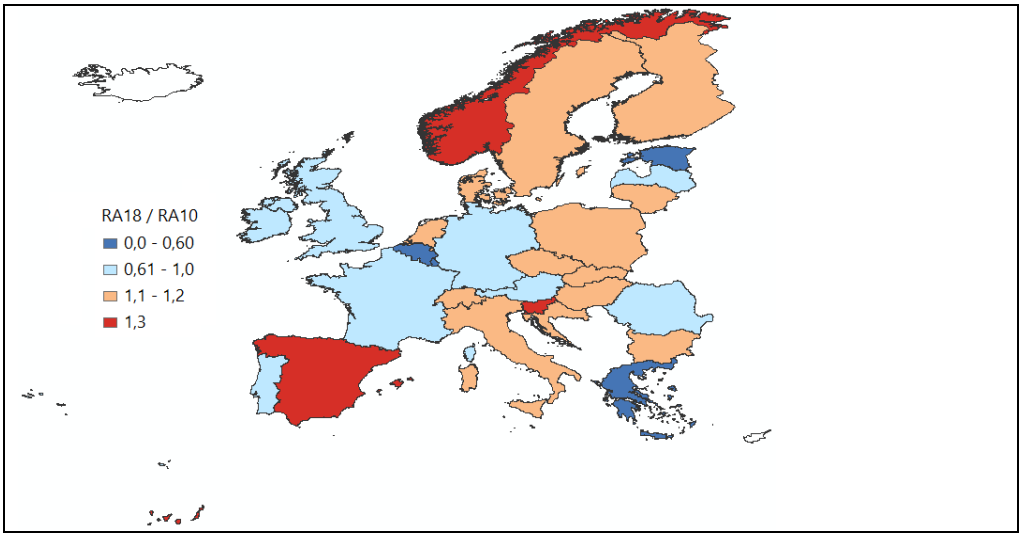


Source: *Own elaboration in ArcMap.*

Figure 2 shows the values of variable RA which, similarly to A, was characterized by a significant spatial diversity in Europe. The maps indicate that the countries with the largest amount of goods transported by rail are Germany and Poland. This involves the transport of goods under the Belt and Road Initiative. The lowest use of rail transport in the entire continent was recorded in the countries of southern Europe (Spain, Portugal, Greece, Croatia and Slovenia) and Scandinavia (Norway, Finland and Estonia). In France, the UK and Italy, an average level of use of rail transport for the transport of goods was observed. The biggest changes in rail transport occurred in Spain, Norway and Slovenia where the change rate was 1.3%, which translates into an increase in the amount of goods moved by rail. Poland and Central and Eastern European countries (Czech Republic, Slovakia, Hungary, Croatia and Bulgaria) recorded a slightly smaller increase of 1.1-1.2%. Decrease in the amount of goods transported by rail was observed in Greece, Belgium and Estonia.

Figure 2. *RA: Goods transported by rail*

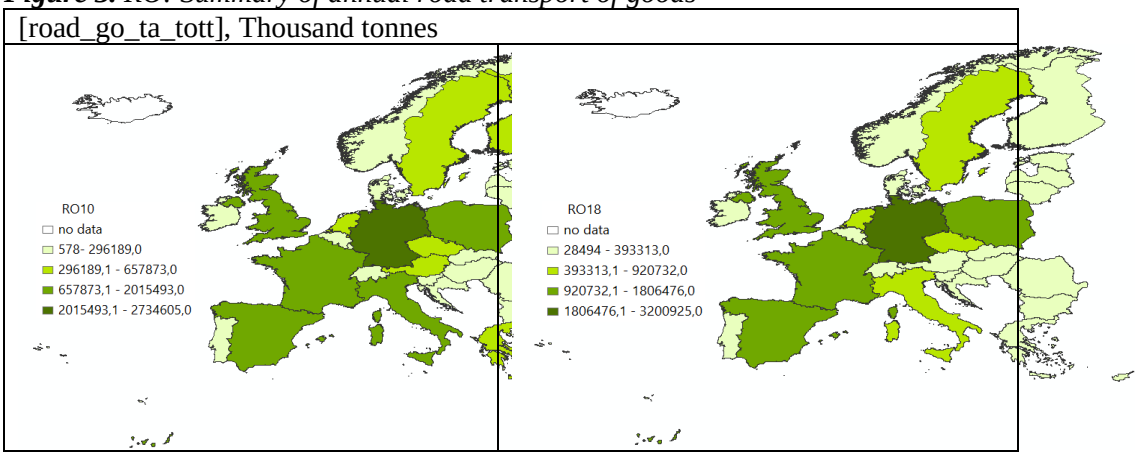


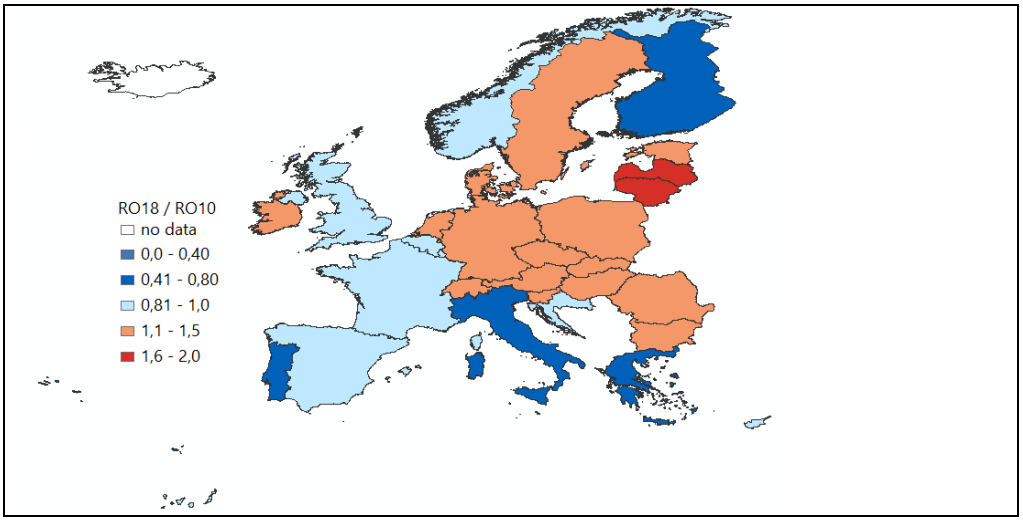


Source: *Own elaboration in ArcMap.*

Figure 3 presents statistical data and analyses for variable RO, which also shows very strong spatial diversification. In Germany, the largest quantities of goods were moved by road transport in all periods studied, which is associated with Germany's first place in European logistics according to LPI. Countries with a high share of road transport in total transport include Poland, France, Spain, Italy and the UK. Relatively small quantities of goods are transported by road in Portugal, Ireland, Norway, Finland, Greece, Bulgaria, Austria, Slovakia and Switzerland. The largest increases in the amount of goods in road transport occurred in the countries of Central and Eastern Europe as well as Germany and Ireland, with the value of the indicator at 1.1-2.0. However, declines were observed in Portugal, Italy, Greece and Finland.

Figure 3. *RO: Summary of annual road transport of goods*



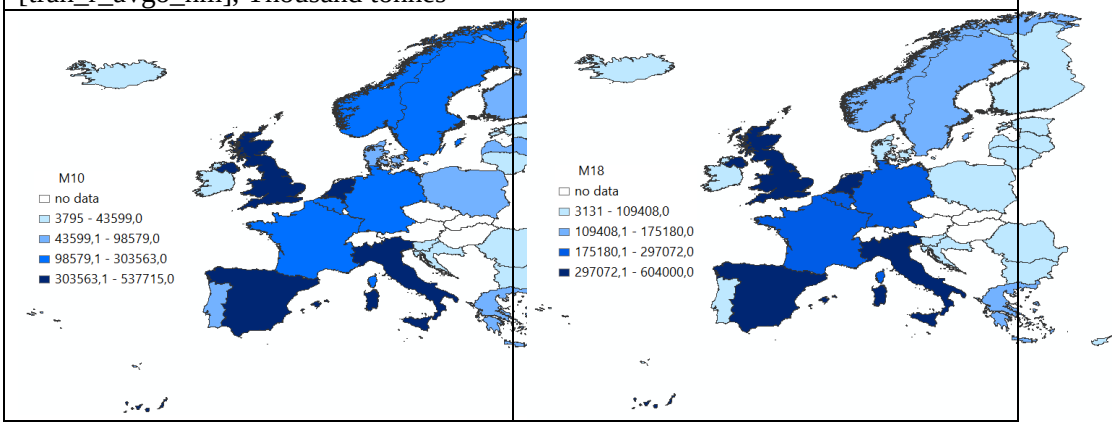


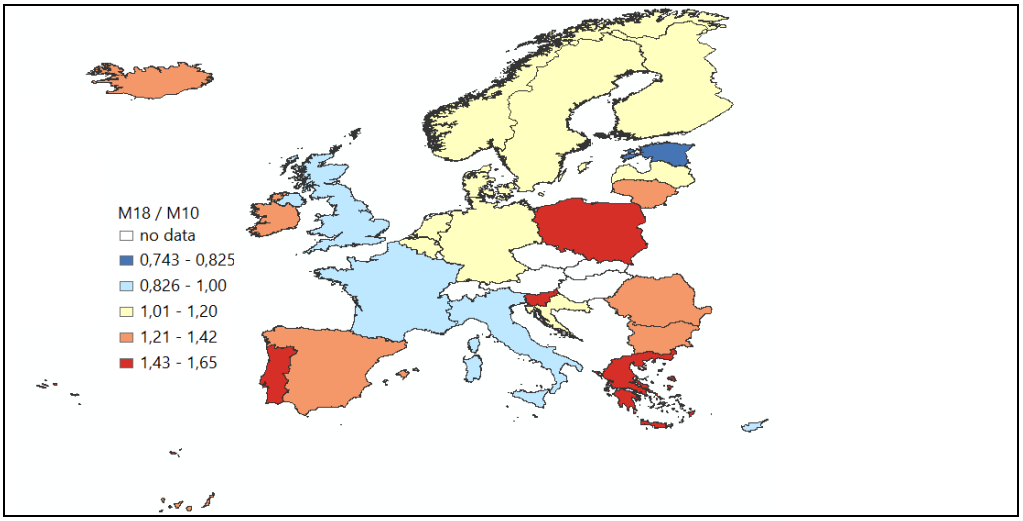
Source: *Own elaboration in ArcMap.*

Figure 4 shows the values of variable M which demonstrates a significant spatial diversity within Europe. The maps indicate that the countries with the largest amount of goods transported by sea are Spain, the UK, the Netherlands and Italy. These countries have highly developed maritime logistics and longstanding traditions in integrating the global supply chain through sea terminals. The most substantial differences in the examined period were observed in Poland, Portugal, Greece and Slovenia, respectively, where the value of the indicator was in the range of 1.43-1.65. In Spain, Ireland, Iceland, Romania and Bulgaria, the differences were observed to a lesser extent, with the value of the indicator in the range of 1.21-1.42 The drop in the quantity of goods transported by sea took place in the UK, France and Italy. The largest European economy, Germany, also recorded an increase with the indicator value from 1.01 to 1.20.

Figure 4. *Maritime transport of goods*

[tran_r_avgo_nm], Thousand tonnes





Source: *Own elaboration in ArcMap.*

The research showed that Poland is one of the European countries in which significant changes in logistics in the form of the development of the logistics system occurred in the years 2010-2018. The most extensive changes in terms of the increase in the volume of transported goods can be observed in maritime transport, followed by rail, road and air. This shows that the logistics system in Poland is increasingly adapting to the logistics requirements of the European single market and international logistics. In the case of road transport, integration of Central and Eastern European countries with Germany is visible, which is related to the development of horizontal integration in the supply chain in many sectors, e.g. automotive. Poland is one of the most important suppliers of parts and components for the automotive industry in Germany.

Countries where the most noteworthy changes in logistics have taken place are also: Norway, Portugal, Spain, Greece, Lithuania, Latvia and Slovenia. In these countries, the largest increases in the volume of transport in particular modes of transport were observed.

5. Conclusions

The results obtained confirmed the existence of considerable differentiation in European logistics in terms of ways of moving goods. The variables applied show the real volumes of goods flows based on the nodal and linear transport infrastructure available in a given country, as well as the networks of terminals and warehouses. Therefore, they approximate the state of development of the logistics sector at the level of the national logistics system, reflecting its specificity. The development of logistics in Poland is primarily based on road and rail, and secondarily, on sea and air transport. The methodology used allowed to identify regions in Europe that showed different logistics development paths in 2010-2018

and those in which there were declines in the volume of freight transport across the transport branch. However, the results constitute the first approximation of the state of logistics in Europe and do not provide in-depth conclusions.

In many aspects, they coincide with World Bank research presented in LPI (Arvis *et al.*, 2018; Rezaei, van Roekel and Tavasszy, 2018). According to LPI, Poland was 30th in the world in 2010 and 27th in 2018, which reflects a three-spot ascent. According to GCI research conducted by the World Forum (Schwab, 2019), Poland occupies the 25th position in the world in the area of transport infrastructure (GCII). The decomposition of this assessment pillar includes the following aspects: road connectivity - 32, quality of road infrastructure - 57, railroad density - 13, efficiency of train services - 45, airport connectivity - 38, efficiency of air transport services - 61, linear shipping connectivity - 23, efficiency of seaport services - 51.

Logistics research in Europe proves that the existing division into Western and Central and Eastern Europe is of lesser importance from the point of view of logistics development. The logistics systems of all countries operating on the single European market have been brought closer and integrated. As a country occupying a special place in Europe, in recent years Poland has made significant progress in the development of logistics, which is confirmed by the high values of the indicator of change in the amount of transported goods by basic modes of transport. In particular, this applies to international road transport, activities of international logistics operators, last mile logistics and rail transport due to the expansion of rail terminals and handling of transport of goods arriving to Europe from China. A large increase in the amount of goods in maritime transport is associated with the implementation of projects aimed at the development of sea terminals in the largest ports of Poland, such as Gdańsk or Gdynia. This also applies to the increase in air cargo handled by airports.

Research results lead to general conclusions showing the main directions of logistics development in Europe and Poland. The research did not include warehouse logistics or inter- and multimodal transport, which in Poland is at the initial stage of growth compared to more developed countries in terms of logistics, such as Germany, France, the Netherlands and the UK. They are the starting point for further in-depth logistics research in Europe using GIS tools to show the relationships at national and regional levels. Including a greater number of variables for modeling omitted in this study will allow for an in-depth analysis of the changes occurring in the area of logistics in Europe.

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