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Comparative analysis of transport management preparedness - evidence from CEE countries

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***Abstract**: Being the most cost-dominant component of the logistics management system, transport plays a vital role in the realization of trade activities across Europe, both on a national and micro level. Various indicators determine the efficiency of the realization of transport activities, amongst which the following hold high importance: quality of transport infrastructure (air, road, maritime, etc.), transport safety and security elements, as well as export/import procedures, etc. This paper aims to perform a comparative analysis among chosen European countries (focusing on CEE countries) concerning the level of transport management preparedness based on the previously mentioned elements. The analysis is performed by using the PROMETHEE II and entropy method. The obtained results should help determine the differences and*

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similarities in transport management preparedness to synchronize better future national policies, strategies, and procedures concerning this issue.

***Keywords**:* transport management, CEE countries, infrastructure, safety and security, import and export procedures.

Komparativna analiza spremnosti za upravljanje transportom - slučaj CIE zemalja

***Apstrakt**: Kao komponenta sa najvećim učešćem u troškovima sistema upravljanja logistikom, transport igra vitalnu ulogu u realizaciji trgovinskih aktivnosti širom Evrope, kako na nacionalnom, tako i na mikro nivou. Efikasnost realizacije saobraćajnih aktivnosti određuju različiti faktori, među kojima veliki značaj imaju: kvalitet saobraćajne infrastrukture (vazdušne, drumske, pomorske i dr.), elementi bezbednosti i sigurnosti saobraćaja, kao i izvozno-uvozne procedure itd. Ovaj rad ima za cilj da izvrši komparativnu analizu odabranih evropskih zemalja (sa fokusom na zemlje Centralne i Istočne Evrope - CIE) u pogledu nivoa spremnodti za upravljanje transportom na osnovu prethodno navedenih elemenata. Analiza se vrši primenom PROMETHEE II i entropijske metode. Dobijeni rezultati bi trebalo da pomognu da se utvrde razlike i sličnosti u spremnosti upravljanja transportom radi bolje sinhronizacije budućih nacionalnih politika, strategija i procedura u ovoj oblasti.*

***Ključne reči**: upravljanje transportom, zemlje CIE, infrastruktura, bezbednost i bezbednost, uvozne i izvozne procedure.*

1. Introduction

The adequate management of the logistics system assumes good coordination of its main subsystems: transport, warehousing, supply management, logistics information system, and procurement. The topic of interest of this paper is precisely one of these subsystems and its importance for the national, macro level of analysis. An empirical analysis testing the level of transport management preparedness is carried out to demonstrate the importance of transport management on a macro level. Testing of the preparedness level is shown through the determination of the efficiency of transport activities that are being carried out, regarding the elements such as quality of transport infrastructure (air, road, maritime, etc.), transport safety and security elements, as well as export/import procedures. The empirical analysis focuses on the situation within CEE countries and the comparison with the situation in the rest of the European countries.

The paper is divided into four parts. The first part refers to a literary review, analyzing the importance and complexity of logistics system management, focusing on transport activity. The importance of transport has been shown regarding its cost participation in total logistics costs, but also on the examples of its significance during different stages of the current Covid-19 pandemic, as well as the transport management preparedness for the challenges on the micro and macro level. The second part of the paper describes the chosen methodology of PROMETHEE II and entropy, as well as the data upon which the analysis has been carried out. The third part of the paper analyzes the obtained results and their discussion. The final part of the paper refers to the concluding remarks.

2. Literature review

The logistics management system represents a unique organization of specific flows of goods and services through time and space, which has significantly evolved from the roots of its military history origin, up to its present integration within the supply chain management philosophy and the context of international operations (Mangan & Lawlani, 2016; Yang & Chen, 2016). The logistics management system's importance and effectiveness have a tremendous effect on the everyday functioning of national companies and economies and international business operations.

The key logistics elements, i.e., subsystems regarding operations within supply chains, are transport, warehousing, supply management, logistics information systems, and procurement (Fugate, Mentzer & Stank, 2010; Hofmann & Rüsch, 2017). Whether it concerns inflow or outflow activities, transport is the most important and complex logistics set of activities in any company dealing with production, trade, and/or performing global business operations (Lee Lam, Cullinane & Tae-Woo Lee, 2018). This is owed to the fact that this set of activities accounts for the most costs- about 50% of the total logistics costs of a company or 50 to 60% of all logistics costs on a macro level (Silva, Goncalves & Alexandre Leite, 2014). Due to this reason, this segment of logistics management, in both national and international surroundings, assumes an important place in the context of the entire business strategy of entities participating in various business operations.

The importance of transport management, apart from its most dominant cost component, has additionally been stressed due to its vital role in organizing the smoothness of operations and transactions during the period of the Covid-19 pandemic (Sun, Wandelt & Zhang, 2020; Budd & Ison, 2020; Forsyth, Guiomard, Niemeier, 2020). The starting point of the pandemic caused

disruptions in the previously established supply chains since the initial economic impact caused the lack of the majority of inputs imported from China. The transport strategies used at that moment to surpass the crisis referred to shortening the supply routes, shifting the modes of transport, usually from maritime and air transport to railroad, as well as optimizing alternative routes of transport delivery (Li, 2020; Choi, 2020; Zhang, 2020). Even the goods that were delivered to the European soil had serious issues regarding distribution and transport management due to the very limited movement of goods and people in the light of the general lockdown during at least the first three months of the pandemic (Falchetta & Noussan, 2020; Gkiotsalitis & Cats, 2020). Transport strategies used at that stage referred to introducing the so-called green corridors. "The system of green corridors was introduced to facilitate the transport and trade of goods within the region, as new border and citizen protection measures to combat the Covid-19 pandemic have greatly slowed traffic. Border crossings and green lanes within this system were open for all goods, with humanitarian goods having higher priority, which required pre-arranged coordination" (Foreign Agricultural service, 2020). An additional challenge for testing the importance and preparedness of the transport system management during the Covid-19 pandemic was set in the realization of the last-mile delivery concept in city logistics, bringing food, medicine, and other fast-moving consumer goods to individual final users in designated areas and destinations (Suguna, Shah, Karthik Raj, Suresh, 2021; Srivatsa Srinivas, Marathe, 2021). Finally, once the vaccines have been put into mass usage, the issue of adequate transportation management under specific conditions, out of which some assumed the implementation of cold supply chains (for example, the Pfizer vaccine), once again proved the importance of this subsystem of logistics management (Eshun-Wilson, Mody, Hoan Tram, Bradley, Sheve, Fox, Thompson, Geng, 2021).

Since the unquestionable importance of adequate transport management has been confirmed through the last analysis elements, an important challenge is to try to keep its preparedness high to meet the demands of the changing market conditions. The preparedness of adequate transport management can be achieved on both the micro and macro levels. Looking at the micro level, i.e., the level of an individual company, numerous business decisions have to be made, ranging from vehicle management, i.e., the choosing of the right mode of transport and its maintenance, efficiency analysis, i.e., which mode of transport is the best and in what occasion; operative decisions such as daily routing and vehicle tracking, but also greater level decisions, concerning strategic planning (Horvat & Foldesi, 2013).

The preparedness of adequate transport management on the macro level can be traced according to several parameters such as quality of infrastructure, transport efficiency, export/import time and procedures, etc. (Lukinskiy &

Pletneva, 2018; Išoraite, 2005; Wang, Chen & Zhang, 2013). The following empirical analysis shall focus on transport management preparedness on a macro level, i.e., on the example of CEE economies and their position compared to other EU countries.

3. Research Methodology

3.1. Data

The multi-criteria approach was used to assess transport management preparedness in CEE economies and their position compared to other EU countries. The PROMETHEE II method is one of the most frequently used multi-criteria methods in such analysis. It was combined with the entropy method, which aims at calculating the weights. The indicators used for the calculations are collected from the Travel & Tourism Competitiveness Report 2019 (Quality of port infrastructure - QPI, Air transport infrastructure quality - ATIQ, Roads quality - RQ, Ground transport efficiency - GTE, Business costs of crime and violence - BCCV, Business costs of terrorism - BCT) and Doing Business database (Time to Export - TE and Time to Import - TI).

3.2. PROMETHEE II method

The PROMETHEE II method is suitable for solving multi-criteria problems requiring ranking the defined set of alternatives according to a number of criteria that should be maximized or minimized. This method was invented by Brans, Mareschal, and Vincke (Brans, J.P. Mareschal, B. Vincke, Ph., 1984) in the late 20th century and is one of the most widely applied. This method has been used in nearly all scientific topics (Despotović & Durkalić, 2017; Remeikienė et al., 2021; Andreopoulou et al., 2018; Radulescu et al., 2017).

The basis of this method is the calculation of the net preference flow, or, to say, the values of each alternative represented in preferences. The observed alternatives are ranked using the net preference flow, a value that synthesizes values of all considered criteria. The PROMETHEE method contains numerous iterations and is available in various forms. In this study, the PROMETHEE II method is applied to ranking the EU countries according to indicators on the

quality of transport infrastructure (air, road, maritime, etc.), transport safety and security elements, as well as export/import procedures.

This method requires the definition of the relevant parameters for each of the considered criteria (Brans et al., 1984; Brans & Mareschal, 2005):

1. Preference direction – this parameter shows if a certain criterion should be minimized or maximized;
2. Weight - it highlights the particular criteria' importance in determining the net preference flow. The greater the weight, the more relevant the ranking criterion. It should be emphasized that the sum of all weights should amount to 1;
3. Preference threshold (p) – this threshold represents the lowest difference between two alternatives regarding certain criteria that the decision-maker finds significant for making the decision;
4. Indifference threshold (q) - this threshold represents the highest difference between two alternatives regarding a given criterion that the decision-maker finds irrelevant for decision-making;
5. Preference function - the chosen function transforms the difference between two alternatives (for example, alternatives x and y) into a level of preference that ranges from 0 to 1 for each criterion individually. The closer the level of preference for alternative x is to 0, the better alternative y is compared to alternative x regarding the given criterion. The closer to 1, alternative x is better than alternative y considering that criterion.

Following the specification of these parameters, the alternatives can be ranked by considering all criteria. The positive and negative preference flows for each alternative are calculated, and the net preference flow is derived based on the difference between these two flows (Vulević & Dragović, 2017). Finally, the observed alternatives are ranked according to the value of net preference flow, which can range between -1 and 1. The best-ranked alternative has the highest positive value of net preference flow, while the last-ranked alternative has the highest negative preference flow.

3.3. Entropy method

The entropy method was employed in this study since one of the parameters that must be defined for the use of this method is the weight for each criterion. Subjectively derived weight coefficients are usually applied when ranking alternatives for decision-making based on decision-maker preferences. On the other hand, objectively calculated weights are commonly used for application multi-criteria analysis for comparative analysis. The objectively determined

weights are commonly applied to eliminate subjectivity during analysis, particularly when multi-criteria approaches are utilized for comparative analysis of various macroeconomic problems. The entropy method, applied in this research, is one of several ways to define weights objectively. The information entropy of the criterion is used by the entropy method to calculate weights. The first step in applying the entropy method is to create a decision matrix.

In some cases, it is necessary to normalize this matrix using the appropriate formula according to the direction of preference (Chen, 2019). Normalization aims to eliminate differences in size and order of magnitude between criteria. The information entropy is obtained after normalization and used to determine the weights in the following step. It is important to keep in mind that the weight is larger, and the information entropy is lower when there is a greater difference between the alternatives. On the other hand, the smaller the difference between alternatives in specific criteria, the lower the information entropy and, hence, the lower the weight coefficient.

4. Results and discussion

Before applying the PROMETHEE II method, it is important to define the previously described multi-criteria analysis parameters based on which the EU countries are ranked. Table 1 shows the evaluation matrix with weight coefficients calculated using the entropy method, as well as other multi-criteria analysis parameters and database.

It can be seen from Table 1 that indicators regarding the quality of transport infrastructure and business safety (QPI, ATIQ, RQ, GTE, BCCV, and BCT) should be maximized. At the same time, the duration of export and import procedures (TE and TI) should be minimized. The V-shape function with the absolute preference threshold amounting to the difference between each indicator's maximum and minimum value to obtain dominance of better alternative when the best and the worst alternatives are compared. If the weight coefficients are compared, it can be noticed that the highest weight coefficient is obtained for the time to export indicator (TE), meaning that the differences among EU countries regarding this indicator are the highest. On the other hand, the lowest weight coefficient is obtained for the time to import indicator (TI); accordingly, the less pronounced differences are recorded for this indicator.

Table 1. Evaluation matrix

Indicators	*QPI*	*ATIQ*	*RQ*	*GTE*	*BCCV*	*BCT*	*TE*	*TI*
min/max	*max*	*max*	*max*	*max*	*max*	*max*	*min*	*min*
weight	*0.118*	*0.123*	*0.145*	*0.105*	*0.079*	*0.109*	*0.254*	*0.068*
preference function	*V-shape*	*V-shape*	*V-shape*	*V-shape*	*V-shape*	*V-shape*	*V-shape*	*V-shape*
thresholds	*Abs.*	*Abs.*	*Abs.*	*Abs.*	*Abs.*	*Abs.*	*Abs.*	*Abs.*
p	*3.6*	*2.8*	*3.2*	*3.0*	*2.6*	*2.3*	*47*	*24*
Austria	*3.7*	*5.1*	*5.9*	*5.4*	*5.3*	*5.7*	*1*	*1*
Belgium	*6.0*	*5.6*	*4.4*	*4.2*	*4.9*	*4.2*	*1*	*1*
Bulgaria	*4.1*	*4.2*	*3.5*	*3.8*	*3.9*	*4.5*	*6*	*2*
Croatia	*4.7*	*4.6*	*5.5*	*3.7*	*5.2*	*5.9*	*1*	*1*
Cyprus	*3.5*	*5.2*	*3.9*	*5.0*	*5.7*	*6.0*	*1*	*1*
Czech Republic	*4.7*	*5.5*	*5.2*	*2.8*	*5.3*	*5.5*	*20*	*17*
Denmark	*5.7*	*6.0*	*5.5*	*4.7*	*4.8*	*4.7*	*1*	*1*
Estonia	*5.7*	*5.2*	*4.7*	*4.8*	*5.7*	*6.0*	*3*	*1*
Finland	*6.3*	*6.3*	*5.3*	*5.8*	*6.5*	*6.5*	*38*	*3*
France	*5.1*	*5.7*	*6.0*	*5.1*	*5.0*	*4.3*	*1*	*1*
Germany	*5.3*	*5.7*	*5.5*	*5.5*	*4.9*	*5.2*	*37*	*1*
Greece	*4.6*	*4.9*	*4.7*	*3.6*	*4.8*	*5.2*	*25*	*2*
Hungary	*3.2*	*4.1*	*3.9*	*4.1*	*5.1*	*5.9*	*1*	*1*
Ireland	*5.1*	*5.4*	*4.5*	*4.0*	*5.0*	*5.4*	*25*	*25*
Italy	*4.5*	*4.7*	*4.4*	*3.9*	*4.1*	*5.0*	*1*	*1*
Latvia	*5.3*	*5.7*	*3.5*	*4.7*	*5.1*	*5.9*	*26*	*1*
Lithuania	*4.8*	*4.4*	*4.7*	*4.6*	*5.3*	*5.8*	*10*	*1*
Luxembourg	*4.6*	*5.6*	*5.3*	*5.0*	*5.8*	*5.8*	*1*	*1*
Malta	*5.2*	*5.6*	*3.2*	*3.9*	*5.8*	*6.1*	*48*	*3*
Netherlands	*6.7*	*6.5*	*6.2*	*5.6*	*5.0*	*5.1*	*1*	*1*
Poland	*4.2*	*4.3*	*4.1*	*4.3*	*4.8*	*5.3*	*1*	*1*
Portugal	*5.2*	*5.4*	*6.1*	*4.7*	*5.8*	*5.9*	*1*	*2*
Romania	*4.0*	*4.3*	*3.0*	*3.5*	*5.5*	*5.6*	*1*	*3*
Slovak Republic	*3.1*	*3.7*	*4.0*	*4.3*	*4.9*	*5.9*	*1*	*4*
Slovenia	*4.9*	*4.4*	*4.7*	*3.8*	*5.7*	*5.8*	*1*	*5*
Spain	*5.6*	*5.9*	*5.6*	*5.4*	*5.4*	*5.4*	*1*	*6*
Sweden	*5.5*	*5.8*	*5.6*	*4.9*	*5.1*	*5.3*	*3*	*7*

Source: Authors' calculations, Travel & Tourism Competitiveness Report 2019, and Doing business database.

Table 1 shows that the Netherlands has the highest indicators of transportation infrastructure quality among EU countries (QPI, ATIQ, RQ, and GTE).

According to Travel & Tourism Competitiveness Report 2019 (World Economic Forum, 2019), this country ranks 3rd globally thanks to high-quality roads (3rd), ports (1st) and railroads (7th), and ground transport efficiency (8th). Among the CEE countries, the highest indicators for quality of port infrastructure and ground transport efficiency (QPI and GTE) are recorded with Estonia. The indicator regarding air transport infrastructure quality (ATIQ) is highest in Latvia, while the highest indicator for the quality of roads (RQ) is recorded in Croatia. On the other hand, the lowest quality of port infrastructure (QPI) and air transport infrastructure (ATIQ) has been recorded in the Slovak Republic, the indicator representing the quality of roads (RQ) is lowest in Romania, and the lowest recorded ground transport efficiency score (GTE) is recorded in the Czech Republic.

Malta has the highest indices in terms of business safety (BCCV and BCT), while Luxembourg has the same score of the business cost of crime and violence (BCCV) but a lower business cost of terrorism score (BCT). Estonia has the highest values for both measures among CEE economies, while Bulgaria has the lowest values for both indicators, reflecting the country's lowest level of safety (BCCV and BCT).

Austria, Belgium, Croatia, Cyprus, Denmark, France, Hungary, Italy, Luxembourg, Netherlands, and Poland are among the EU countries that have decreased the time it takes to export and import to one hour. As can be seen, most CEE economies' import and/or export processes take more than an hour. The Czech Republic has the most unfavorable situation among these economies, with exports taking an average of 20 hours and imports taking an average of 17 hours. However, several EU countries have procedures that take much longer. Exports take an average of 48 hours in Malta, while import procedures take the longest in Ireland (25 hours).

The ranking of EU economies was carried out using the above parameters and database. Table 2 displays the ranking results as well as the value of positive, negative, and net flow preferences.

According to the results presented in Table 2, it can be noted that the best-ranged EU country according to all observed indicators is the Netherlands, followed by Portugal, Spain, Luxembourg, Estonia, Sweden, Austria, Denmark, Finland, France, Croatia, Cyprus, Slovenia, and Belgium as countries with the positive net preference flow, meaning that the advantages of these countries overcome their disadvantages. It can be seen that only Estonia, Croatia, and Slovenia have positive net preference flow among CEE economies. The negative net preference flow and, accordingly, the highest disadvantages in comparison to advantages are present in the following economies: Lithuania,

Germany, Poland, Italy, Latvia, Hungary, Slovak Republic, Romania, Czech Republic, Greece, Ireland, Bulgaria, and Malta.

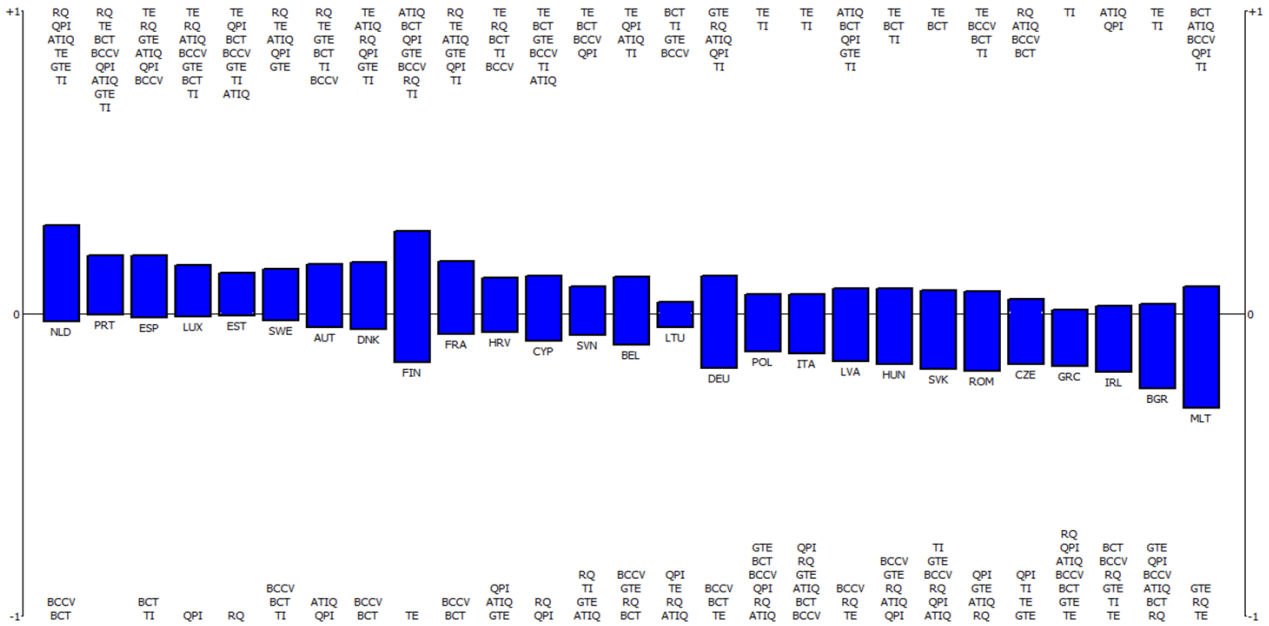
Table 2. Ranking results

Rank	Country	Phi	Phi+	Phi-
1	Netherlands	0.2602	0.2939	0.0337
2	Portugal	0.1836	0.2107	0.0271
3	Spain	0.1729	0.2098	0.0369
4	Luxembourg	0.1436	0.1808	0.0372
5	Estonia	0.1228	0.1733	0.0505
6	Sweden	0.1182	0.1767	0.0585
7	Austria	0.1123	0.1820	0.0697
8	Denmark	0.1117	0.1820	0.0703
9	Finland	0.1058	0.2792	0.1734
10	France	0.1023	0.1853	0.0829
11	Croatia	0.0495	0.1380	0.0885
12	Cyprus	0.0290	0.1409	0.1119
13	Slovenia	0.0125	0.1213	0.1088
14	Belgium	0.0123	0.1385	0.1262
15	Lithuania	-0.0132	0.1085	0.1217
16	Germany	-0.0603	0.1417	0.2020
17	Poland	-0.0673	0.0851	0.1524
18	Italy	-0.0764	0.0862	0.1626
19	Latvia	-0.0809	0.1081	0.1890
20	Hungary	-0.0880	0.0926	0.1805
21	Slovak Republic	-0.1126	0.0905	0.2031
22	Romania	-0.1238	0.0848	0.2086
23	Czech Republic	-0.1262	0.0969	0.2232
24	Greece	-0.1661	0.0589	0.2250
25	Ireland	-0.1722	0.0743	0.2464
26	Bulgaria	-0.2205	0.0528	0.2733
27	Malta	-0.2292	0.1016	0.3307

Source: Authors' calculations.

To explain such ranking results, the characteristics of analyzed countries are presented in Figure 2. The rainbow diagram presented in Figure 2 shows the advantages of all countries (above the histogram) and their disadvantages (below the histogram).

Figure 1. Rainbow diagram



Analyzing the characteristics of CEE economies in Figure 2, it can be concluded that Estonia, as a best-ranked CEE country, has a disadvantage compared to other countries only regarding the quality of roads (RQ). In contrast, the remaining aspects of transport preparedness have significantly improved in the previous period. So, this country was the most prepared for pandemic distortions in transporting goods. Croatia is ranked 11th in the final rankings but still has a positive net preference flow. This relatively favorable position in this country owes to the shortening of the duration of export and import procedures (TE and TI), improvements in the safety of business activities (BCCV and BCT), and the quality of roads (RQ). Slovenia is positioned in the middle of all EU Member States rankings, but it is third among CEE economies. This country has made progress in obtaining business activities safety (BCCV and BCT), shortening the export procedures (TE), and improving the quality of port infrastructure (QPI). However, this country should improve the quality of other transport types (RQ, GTE, and ATIQ) and shorten the import procedures (TI).

The CEE economies with negative net preference flow have a disadvantage in most of the observed criteria. The number of disadvantages and ranking positions depends on how pronounced they are. The remaining Baltic States, Latvia and Lithuania, have disadvantages regarding the low-quality roads (RQ) and long-lasting export procedures (TE). Besides these disadvantages, Latvia has high business costs of crime and violence. This country has fewer disadvantages than Lithuania and has the worst position in the final rankings, suggesting that its disadvantages are more pronounced. Lithuania should improve the quality of port infrastructure (QPI) and air transport infrastructure (ATIQ). The so-called Visegrad countries (Poland, Hungary, Slovak Republic, and Czech Republic) have a disadvantage in the majority of observed indicators, especially those related to the quality of transport infrastructure (QPI, ATIQ, RQ, and GTE). The Southern European economies (Romania and Bulgaria) also have numerous disadvantages. Both economies have low-quality transport infrastructure (QPI, ATIQ, RQ, and GTE). However, Bulgaria is the last-ranked CEE economy because it has high business costs of crime, violence, and terrorism (BCCV and BCT).

5. Conclusions

The analysis within the paper has shown that transport is considered the most important group of logistics activities due to its cost domination and proven importance during the ongoing Covid-19 pandemic. The analysis within this paper has also dealt with the preparedness of the transport management system regarding the efficiency of its realization and focusing thereby on various important elements: Quality of port infrastructure - QPI, Air transport

infrastructure quality - ATIQ, Roads quality - RQ, Ground transport efficiency - GTE, Business costs of crime and violence - BCCV, Business costs of terrorism – BCT, Time to Export - TE and Time to Import – TI.

The carried out empirical analysis has shown that there are still significant differences among CEE countries regarding the level of sophistication and proficiency in realizing the stated elements of transport management system preparedness. This shows that more serious efforts need to be put into harmonizing the level of achieved results in various aspects of transport management on a macro level. This will help achieve a more unified and stable EU business market for all entities which are a part of it, but also those which tend to become a part of it one day, such is the situation with Serbia. This will also increase the quality of transport activities of individual firms belonging to this market, aiding them to be more competitive and achieve a long-term advantage within business operations in the business milieu of the future.

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