PROBLEMY EKOROZWOJU – PROBLEMS OF SUSTAINABLE DEVELOPMENT
2022, 17(2): 91-101
DOI: 10.35784/pe.2022.2.10

Transition of Logistics to Sustainable Development Under the Impact of COVID-19

Zmiany w logistyce w kierunku zrównoważonego rozwoju pod wpływem COVID-19

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Abstract

The pandemic has clearly demonstrated the global interdependence of states and contributed to the formation of new trends that have changed the image of traditional logistics. Modern logistics, being in a state of transition, has faced not only short-term challenges such as COVID-19, but also long-term problems ranging from structural shifts in production and marketing processes and globalization patterns, and ending with changes in consumption patterns and resource spending, as well as a broad global agenda in the field of sustainable development. In this regard, there is a need to develop theoretical and applied aspects of the transition of logistics to sustainable development under the influence of COVID-19. The theoretical basis was the scientific works of domestic and foreign authors in the field of logistics, sustainable development, certain provisions of international framework documents. The initial information for analysis, forecasting and drawing conclusions was the official data of the Statistical office of the European Union (Eurostat), the State Statistics Service of Ukraine (Goskomstat), International Civil Aviation Organization (ICAO), International Transport Forum (ITF), United Nations Conference on Trade and Development (UNCTAD). As a result of the generalization of the theoretical and methodological foundations of logistics, the article proposes the author's definition of sustainable logistics, which made it possible to expand the

scientific vision of its content, taking into account modern challenges, as well as to identify its role in ensuring sustainable development. An analysis was made of the development of transport logistics before and during the pandemic. A forecast of freight turnover by type of transport for 2022 has been built. The main trends in the transition of logistics to sustainable development under the influence of COVID-19 are identified.

Keywords: logistics, transport logistics, sustainable logistics, sustainable development
Słowa kluczowe: logistyka, logistyka transportu, zrównoważona logistyka, zrównoważony rozwój

Introduction

Logistics is a key sector of the global economy and plays a vital role in today's mobile society. Being multifaceted and complex in nature, logistics is associated with a huge number of business-to-business (B2B) and business-to-customer (B2C) logistics fragments. It affects almost all areas of activity, ranging from the mining industry and agriculture, and ending with the supply of goods to store shelves, points of issue of online orders or delivery by a courier. Inconsistency in the interaction of any fragments of logistics chains leads to production delays, increased costs, failure of contracts, reputational losses, which negatively affects the socio-economic development of the regions. Consequently, logistics and its condition are reflected in sustainable development.

This fact is confirmed by experts from various European countries, as well as official statistics, according to which the restriction of passenger traffic within 2019-2021, being a mandatory norm to counter the spread of coronavirus, led to irreversible transformations in logistics processes and significant losses not only in the transport industry, which requires stepping up the actions of the government, science and business in the direction of eliminating post-covid consequences.

Sustainable logistics operations improve the availability of goods, improve urban resilience, urban-rural connectivity and rural productivity with minimal environmental impact, thereby accelerating economic growth. In this regard, the study of transport logistics in the transition period to sustainable development under the influence of COVID-19 is gaining more relevance.

This is evidenced by a set of international norms developed by the Inland Transport Committee of the United Nations Economic Commission for Europe that govern the creation of a sustainable transport sector that will continue to serve the needs of the economy and citizens, while respecting future constraints: oil shortages, increasing congestion, the need to reduce CO_2 and pollutant emission in order to improve air quality, especially in cities. The key aspects of the EU's transport policy are set out in the White Paper *Roadmap to a Single European Transport Area*, which focuses on reducing greenhouse gas emissions by 60% by 2050 compared to 1990 and reducing dependence on imported oil.

As part of the European Green Deal, which according to experts is also a lifeline from the COVID-19 pandemic, strategic priorities have been set for a climate-neutral EU economy by 2050, including the development of multimodal transport, support for the deployment of automated and connected mobility solutions for different types of transport, better removing the external costs of transport activities through pricing, increasing the production and deployment of environmentally friendly alternative fuels for transport, and reducing pollution from it, especially in cities (Official website of the European Union, 2021). Based on the foregoing, the **purpose of the article** is to develop theoretical and applied aspects of the transition of logistics to sustainable development under the influence of COVID-19.

1. Methodology

To solve the problem presented for consideration, the article used a comprehensive and systematic approach that involves taking into account the interaction of diverse processes, events, phenomena that determine the transition of logistics to sustainable development under the influence of COVID-19.

Interpretation of key theoretical positions was carried out on the basis of general scientific methods, namely: deduction, analysis, synthesis, forecasting. Thus, in particular, the deduction method was used to formulate the definitions of *logistics* and *sustainable logistics*, as a result of which it was possible to consistently build a number of conclusions and form the author's vision regarding the interpretation of these concepts.

The identification of the main trends in the development of transport logistics before and during the pandemic was carried out using analysis, synthesis and forecasting. The initial information for the analysis and forecast was the official statistical data of the Statistical office of the European Union (Eurostat), the State Statistics Service of Ukraine (Goskomstat), International Civil Aviation Organization (ICAO), International Transport Forum (ITF), United Nations Conference on Trade and Development (UNCTAD). Freight turnover by motor, railway, river and air transport was taken as a base indicator for analysis.

2. Findings and Discussion

2.1. Formation and development of theoretical and methodological foundations of logistics

Regular research of the authors of this article made it possible to establish the fact that the term *logistics* has been used since the time of imperial Byzantium. Back then, there were *logisticians* at the royal court who were engaged

in the purchase and distribution of food. The term logistics became widespread during the war between Byzantium and the Turks (1422). It was used to describe the comprehensive support of the belligerent parties. The formation of logistics as a new business paradigm dates back to the 80s of the 20th century. This fact was due to the deepening of specialization and cooperation, which contributed to the formation of a system of increased requirements of enterprises to their production partners (Krykavskyy Y, 2014).

Despite the six centuries of history, it has been established that so far there is no generally accepted definition of logistics. Such scientists as V. Shishkin, O. Onishchenko, I. Revutskyy (2019), I. Puzanova; B. Anikina (2014), A. Ellaryan (2015), note that the definition of this term is becoming more complicated every year due to the dynamics of its development and the emergence of new directions and principles of logistics. The authors of this study share the point of view of the scientists mentioned above, believing that most of the existing definitions of logistics describe only a certain applied logistics area and is not a universal definition.

Along with economic, social, cultural, technological and other transformations in the world, which led to changes in the vectors of research and interpretation of individual logistics categories, the pandemic of 2019 exposed even more problems of modern logistics. As a result, US Business Schools are updating their supply chain courses to prepare a new generation of logistics managers for future crises. For example, Skrikant Datar, dean of the Harvard Business School, notes that *for many years we took logistics for granted, but the pandemic forced us to rethink it* (Harvard Business School, 2022). Matthew Boyle writes that this is one of the forms of reaction of academic circles as the pandemic devalues the textbooks that have guided the field since the 1990s (Brendan Murray, 2021).

In this regard, we consider it appropriate to propose to understand logistics as the area of theoretical and applied knowledge about the optimal management of discrete and continuous flows of integrated support for the production of goods and services, which is at the same time a tool for competition, profit and sustainable development. At the same time, the entire production cycle up to the sale of goods and services to end consumers is considered to be a comprehensive provision in the article.

It should be noted that modern logistics science distinguishes a wide variety of its types. Thus, in the studies of A. Galkin, Yu. Popova, Y. Chuprina, D. Shapovalenko, who considered the interaction of logistics and consumer marketing using ICT, the authors single out transport, procurement, information, production, distribution, warehouse, customs logistics, as well as inventory logistics (Galkin A., Popova Y., Chuprina E., Shapovalenko D., 2019). A similar approach is presented in the studies of I. Sharova (2015), N. Vasilchuk (2016), T. Shulzhenko (2016) V. Shcherbakov, V. Silkina (2017). Based on this, we came to the conclusion that almost every type corresponds to some structural functional unit of the company, each of which is interconnected with logistics.

In addition, studies of scientific publications devoted to this issue have made it possible to establish that with the advent of the concept of sustainable development, science has been replenished with new concepts and definitions. So, in particular, such terms as: *green supply chains, green logistics, environmental logistics, sustainable logistics* appeared. The need to introduce these categories is explained by the fact that logistics has significant potential for environmental control of transport systems, product disposal processes, minimization of environmental pollution, energy and resource saving. Moreover, according to N. Osintsev, A. Rakhmangulov, V. Baginova, the management of material and related flows, based on the principles of logistics, initially includes a reduction in the environmental burden on the environment (Osintsev N., Rakhmangulov A., Baginova V., 2018).

Based on what the authors of this article have said, sustainable logistics is understood as an area of theoretical and applied knowledge about the optimal management of discrete and continuous flows in production, the main goal of which is to meet the needs of all stakeholders of the logistics system while minimizing the negative impact on the environment and achieving a stable balance between environmental, economic and social tasks of the logistics system.

Comparing the definitions of *logistics* and *sustainable logistics*, we came to the conclusion that the goal of *traditional* logistics is to coordinate various types of resources and flows (including informational, material, human, financial, etc.) to satisfy all participants in the logistics subsystem at minimal cost, while *sustainable logistics* is aimed more at coordinating various types of resources and flows (including information, material, human, financial, etc.) to satisfy all participants in the logistics subsystem while achieving sustainability between economy, environment and society.

It is important to note that the implementation of sustainable logistics is ensured through the formation of the sustainability of all the constituent elements of supply chains, which ultimately will not only contribute to ensuring competitive advantages, but will also allow the implementation of the key tasks of the concept of sustainable development. The substantiation of this thesis was reflected in the works of not only the authors of the article, but also other scientists. In particular, this is stated in the studies of N. Parkhomenko, I. Otenko (2018), E. Boichenko, N. Martynovych, I. Shevchenko (2021). In earlier studies of M. Kutsenko (2009) he presented a rationale for the comprehensive optimization of the design parameters of sorting devices for rail transportation, which not only significantly reduce the operating costs of the sorting process, but also contribute to ensuring sustainable principles of rail transportation.

O. Kostiennikov (2010) proposed measures to improve the technologies for regulating rolling stock for the transportation of seasonal goods. P. Yaremovych, in regular studies conducted from 2000 to the present, provides analytical reviews, on the basis of which the author established significant transformations in the field of logistics, which, in his opinion, require an integrated approach for a large-scale transition to sustainable development in general, and implementation sustainable logistics in particular.

Despite the differences in scientific interests, the authors came to the consensus that for the period 2019-2021 significant changes have taken place in the structure of logistics operations associated with the spread of acute respiratory disease COVID-19 caused by the SARS-CoV-2 coronavirus and requiring comprehensive efforts simultaneously in all areas of the supply chains. Further in the paragraphs, fragments of the results of the study of transport logistics (motor and railway transport) are presented, on the basis of which author's developments are formulated to improve transport devices and sustainable logistics operations.

2.2. Analysis of the development of transport logistics before the pandemic: identification of the main trends

2.2.1. Analysis of the freight turnover of motor transport

An analysis of the development of transport logistics before the pandemic revealed that the reduction in the volume of road freight transport in Europe began in 2011 and amounted to 1%. At the same time, the trend of tonnage growth and reduction of national, international and intersectoral traffic has been established. More clearly, the freight turnover of road and rail transport before the pandemic, in the context of European countries over a five-year period (million tkm), is presented in (Tables 1-2).

According to the data presented in (Table 1), it follows that since 2013, a steady upward trend in road freight turnover has been observed in such countries as: Greece, Ireland, Spain, Poland, Romania, Slovakia, Slovenia, Croatia. The increase in the volume of transportation occurred due to an increase in the volume of household and office freight, since construction products are the main group by tonnage (Eurostat).

Table 1. Dynamics of freight turnover of motor transport before the pandemic, by European countries for 2013-2017, million tkm, compiled by the authors according to (Eurostat, 2017; Derzhkomstat, 2017)

Countries	2013	2014	2015	2016	2017
Austria	24213	25260	25458	26138	25978
Belgium	32796	31808	36078	35192	34220
Bulgaria	27097	27854	32297	35409	35150
Great Britain	139703	135393	150101	155042	153939
Hungary	35818	37517	38353	40002	39684
Greece	16583	19223	19764	24560	28377
Denmark	16072	16184	15500	16094	15502
Ireland	9215	9751	9900	11616	11836
Spain	192597	195767	209390	216997	231109
Italy	127241	117813	116820	112637	119687
Cyprus	634	538	563	703	826
Latvia	12816	13670	14690	14227	14972
Lithuania	26338	28067	26485	30974	39099
Luxembourg	8606	9599	8850	9324	9414
Malta	–	–	–	–	–
the Netherlands	72081	72338	68900	67779	67533
Germany	305744	310142	314816	315774	313149
Poland	247594	250931	260713	290749	335220
Portugal	36555	34863	31835	34877	34186
Romania	34026	35136	39023	48176	54704
Slovakia	30147	31358	33540	36139	35411
Slovenia	15905	16273	17909	18707	20814
Ukraine	58683	55964	53293	58030	62297
Finland	24429	23401	24488	26846	27966
France	171472	165225	153580	155843	167691
Croatia	9133	9381	10439	11337	11834
Czech Republic	54893	54092	58715	50315	44274
Sweden	33529	41964	41502	42673	41851
Estonia	5986	6310	6263	6716	6189

Steady growth trend in the freight turnover of motor transport
Steady trend of decline in the freight turnover of motor transport
Unstable trend in the freight turnover of motor transport

According to the data in the table, in the vast majority of European countries – 69%, during the analyzed period there was a tendency of slight fluctuations in the freight turnover of motor transport. In addition, the analysis of earlier periods made it possible to establish that in Latvia, Lithuania and Bulgaria in 2011 a significant increase in the transported tkm was recorded. In general, it should be noted that freight traffic for all distance classes in 2013 was below the level of 2007 (Eurostat). Poland achieved growth in all distance classes. Bulgaria has seen an increase for all but the shortest distances, less than 50 km (Eurostat). The negative trend in the period *before the pandemic* was observed only in Italy.

In the period from 2007 to 2011, there was also a decrease in motor freight transport for distances of less than 300 km (-9%) in almost all regions of Europe. This trend, among other things, can be explained by the adoption of a strategy for the formation of a single European transport area in March 2011 by the European Commission, the goals of which are reflected in the White Paper and include a halving of the use of cars running on conventional fuel in urban transport by 2030; phasing them out in cities by 2050; achieving virtually CO_2-free urban logistics in major urban centers by 2030 (Eurostat, 2021).

In Ukraine, the decline in road freight traffic began in 2012 and lasted until 2015. This is due to the decline in production, which amounted to (-13%) in 2012-2013 and (-37%) in 2014-2015. This trend was mainly due to Russian aggression in eastern Ukraine in 2014. However, already in 2016, there is a gradual recovery, the growth of which amounted to (+ 107.35%). The growth in freight turnover was primarily due to local transportation of clay, peat, granite, agricultural products, mainly grain (Derzhkomstat, 2014, 2015).

2.2.2. Analysis of freight turnover of railway transport

An analysis of the freight turnover of railway transport (Table 2) made it possible to establish that the vast majority of European countries in the period from 2013 to 2017 were characterized by unstable trends in freight turnover, which in percentage terms corresponds to 69%.

Table 2. Dynamics of freight turnover of railway transport before the pandemic, by European countries for 2013-2017, million tkm (compiled by the authors according to (Eurostat, 2017; Derzhkomstat, 2017)

Countries	2013	2014	2015	2016	2017
Austria	19356	20746	20814	21361	22256
Belgium	–	–	–	–	–
Bulgaria	3246	3439	3650	3434	3931
Great Britain	22401	22143	19342	17053	17167
Hungary	9722	10158	10010	10528	13356
Greece	237	311	294	254	358
Denmark	2449	2453	2603	2616	2653
Ireland	99	100	96	101	100
Spain	9338	10385	11028	10550	10549
Italy	**19037**	**20157**	**20781**	**22712**	**22335**
Cyprus	–	–	–	–	–
Latvia	19532	19441	18906	15873	15014
Lithuania	13344	14307	14036	13790	15414
Luxembourg	218	208	207	201	213
Malta	–	–	–	–	–
the Netherlands	6078	6169	6545	6641	6467
Germany	**112613**	**112629**	**116632**	**116164**	**112232**
Poland	50881	50073	50603	50650	54797
Portugal	2290	2434	2688	2774	2751
Romania	12941	12264	13673	13535	13782
Slovakia	8494	8829	8439	8370	8477
Slovenia	3799	4110	4175	4360	5128
Ukraine	**224434**	**210157**	**195054**	**187557**	**191914**
Finland	9470	9597	8468	9456	10362
France	**32230**	**32596**	**34252**	**32569**	**33442**
Croatia	2086	2119	2184	2160	2592
Czech Republic	13965	14575	15261	15619	15843
Sweden	**20970**	**21296**	**20699**	**21406**	**21838**
Estonia	4722	3256	3117	2340	2325

Steady growth trend in the freight turnover of railway transport
Steady trend of decline in the freight turnover of railway transport
Unstable trend in the freight turnover of railway transport

However, in the vast majority of countries, this instability can be considered insignificant, since the average deviation of the fall in freight turnover varied within 200-250 million tkm, and also did not have a regular drop in

dynamics. So, for example, in Bulgaria, a drop in freight turnover was established only in 2016, and it amounted to 6%. In Hungary such a drop was noted in 2015 (-1.46%), but in 2017 an increase of (+33%) was established. A similar trend is observed in all other countries that were included in the gradation – *Unstable trend in the freight turnover of railway transport.*

Three countries turned out to have a negative trend in freight turnover: Great Britain, Latvia, Estonia -12%, and a positive trend was observed in 19% of countries – Austria, Denmark, Portugal, Slovakia, Czech Republic.

An analysis of the overall dynamics of railway transport freight turnover before the pandemic in the context of European countries indicates that in 2013 there was an increase (+1.2%). This trend continued in the next two periods. So in 2014 it was (+1.1%), and in 2015 it was (+1.2%). In 2016, there was a (-0.9%) decrease in railway transport freight turnover, but it was immediately followed by a significant increase in 2017 and 2018 (+3.1% and +3.0% respectively), peaking at almost 400 billion ton-kilometres (tkm) (Eurostat).

Being a European state, the trends in Ukraine differ from the general European ones, which, according to the authors of the article, may negatively affect the development of logistics in general in the future. Thus, in Ukraine there is a steady trend to reduce freight traffic. For the period of 2013-2017 structural changes have been established, which are characterized by a reduction in freight turnover by railway and an increase in the share of motor transport. According to official statistics, in 2014, freight traffic by Ukrzaliznytsia decreased from 62.5% to 55.9% in 2017, and vice versa, the share of road transportation increased from 11.3% in 2014 to 12% in 2017 (Derzhkomstat). Based on the presented analysis, we can conclude that in general, for the period of 2013-2017 there was a positive trend in railway freight turnover in Europe (with the exception of Ukraine).

2.2.3. Analysis of freight turnover of river transport

Analysis of freight turnover of river transport (Table 3) allowed us to establish that this type of transport has a steady tendency to reduce freight turnover even in the *pre-pandemic* period. The UK, Italy and France are marked with a negative trend. All other countries have an unstable downward trend. For example, in Luxembourg and Germany, only in 2017 there was a slight increase in freight turnover (+2.6% and 2.16%, respectively). Even the Netherlands, being the largest country of maritime freight transportation in Europe, showed a decrease in freight turnover by -1.6% in 2015.

Table 3. Dynamics of freight turnover of river transport before the pandemic, by European countries for 2013-2017, million tkm, compiled by the authors according to (Eurostat, 2017; Derzhkomstat, 2017)

Countries	2013	2014	2015	2016	2017
Austria	2353	2177	1806	1962	2022
Belgium	10365	10451	10426	10331	11098
Bulgaria	5374	5074	5595	5477	5279
Great Britain	211	169	120	108	–
Hungary	1924	1811	1824	1975	1992
Italy	89	64	62	–	–
Lithuania	–	–	–	–	–
Luxembourg	313	285	235	190	195
the Netherlands	48641	49327	48535	48798	49015
Germany	60070	59093	55315	54347	55518
Poland	91	110	88	108	115
Romania	12242	11760	13168	13153	12517
Slovakia	1006	905	741	903	933
Ukraine	1387	1358	1572	1465	1423
Finland	121	135	128	103	–
France	9201	8789	8506	8307	7513
Croatia	771	716	879	836	813
Czech Republic	25	27	33	36	25

Steady growth trend in the freight turnover of river transport
Steady trend of decline in the freight turnover of river transport
Unstable trend in the freight turnover of river transport

This state of affairs is primarily due to the reduction in the freight turnover of maritime transport, which accounts for 90% of the world's freight turnover in world trade. The popularity of maritime transport is explained by its lowest cost compared to other modes of transport. However, this mode of transport is also the least environmentally friendly, which contradicts the main directions of the concept of sustainable development, and in connection with which the marine community, having imposed stricter rules on environmental requirements, has affected the reduction of maritime transport activity.

2.2.4. Analysis of freight turnover of air transport

First of all, it should be noted that the transportation of commercial goods by air is traditionally less common both in Europe and in the world, due to its high cost. Therefore, the air transport freight turnover in the context of European countries is not significant, which makes it difficult to collect data due to the lack of unified regular statistical information, based on which the results of the world air transport freight turnover survey are presented below. According to the official data of the International Civil Aviation Organization (hereinafter ICAO) for the period of 2013-2017, there was a steady trend of growth in the volume of regular air freight transportation in the world (Fig. 1).

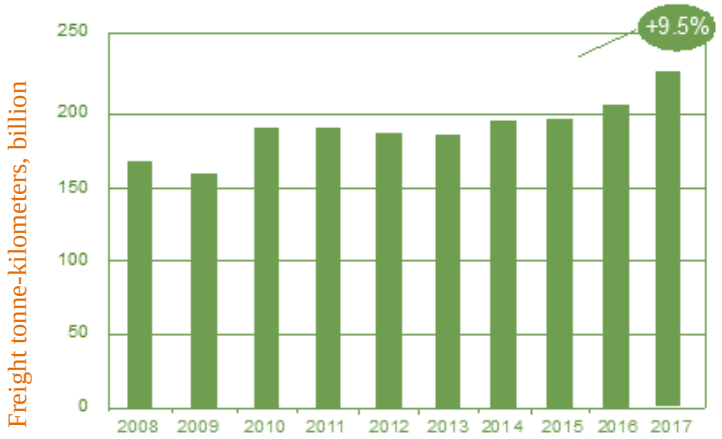

Figure 1. Dynamics of global air transport freight turnover before the pandemic in 2008-2017, billion tkm, compiled by the authors according to the ICAO (2017)

Growth of global air transport freight turnover over the past five years took place mainly due to the intensification of trade and amounted to (+9.5%). The share of international air freight transportation accounted for about 87% of the total volume of regular traffic. Almost 40% of international scheduled flights were carried out by airlines of the Asia-Pacific region. For European carriers, this figure was 26%. For airlines in the Middle East -16%, and for airlines in North America -14%. This means that almost 80% of long-haul freight traffic was carried out along the East-West trade corridor connecting Asia with Europe, Asia with North America and Europe with North America (ICAO, 2017).

In addition, it was found that the freight turnover of air transport in 2017 amounted to 351 billion, which is 6.1% higher than in 2016, while the load factor increased from 53.2% in 2016 to 55.4% in 2017. The combination of trade activation and the growth of e-commerce volumes had a positive impact on air freight transportation in 2013-2017. This trend allows us to talk about a steady trend in the growth of air transport freight turnover.

Summing up the four indicators of the development of transport logistics before the coronavirus period (freight turnover, passenger turnover of motor and railway transport) of European countries, a generally positive trend has been established.

In European countries, with the exception of Ukraine, there was a predominance of freight turnover of motor transport over railway. However, this trend tends to change, since there is an increase in freight turnover by rail and a reduction in road transport. In Ukraine, on the contrary, after the restoration of industrial production and an increase in foreign trade turnover, structural changes in freight turnover have been established, characterized by the predominance of railway transport, but its share in the aggregate of transport logistics operations is decreasing in favor of motor transport.

2.3. Analysis of the development of transport logistics during the pandemic: identification of the main trends

2.3.1. Analysis of the freight turnover of motor transport

An analysis of the development of transport logistics during the pandemic allowed us to establish that the transport and logistics system turned out to be one of the most affected areas as a result of the COVID-19 pandemic. According to the International Transport Forum, the overall reduction in global transport traffic for the period of 2019-2021 amounted to 36% compared to the pre-crisis level (International Transport Forum, 2021).

European motor freight transport was no exception, which decreased by 0.9% in 2019, thereby breaking the growth trend observed in previous years (Eurostat, 2020). The increase in the drop in freight turnover of motor transport was in the second quarter of 2020. In this connection, international traffic, which makes up a quarter (24.8%) of all road freight traffic in the EU, decreased by (-3.8%). A steady negative trend in freight turnover by road was established in Portugal (-21.8%), Cyprus (-17.4%) and Luxembourg (-16.3%).

However, during the same period, a steady increase in cabotage traffic was revealed, which for the period of 2019-2020 amounted to (+4.4%). The largest freight turnover of cabotage transportation in Europe in 2019-2020 fell on Poland (19.7%), Germany (16.9%) and Spain (13.4%) and amounted to 65%. Positive trend of freight turnover by motor transport for the period of 2019-2020 was also noted in the Czech Republic (+17.0 billion tkm; +43.6%) and Bulgaria (+12.0 billion tkm; +58.5%).
Despite the positive dynamics of cabotage transportation in general, a general trend of reducing freight turnover by all modes of transport has been established over the analyzed period. Thus, in Germany, Spain, Luxembourg, Hungary, the Netherlands, Portugal and Slovakia, there is a drop ranging from -2.3% to -21.8% of the total volume of traffic (Eurostat, 2020). It has been established that in 2020, long-distance motor transport over 2000 km has sharply decreased. The main part of motor transport in Europe was carried out over distances from 50 km to 1,999 km, which accounted for 89.3% of the total volume. This trend was formed due to the blocking and restrictions on border movement introduced in many countries in 2020 to counter the COVID-19 pandemic (Eurostat, 2020).
Based on the presented analysis, we came to the conclusion that the pandemic not only reduced the turnover of goods by road in Europe, but also contributed to a change in its structure. In addition, from the perspective of sustainable development, this type of transport at this stage of the functioning of the logistics system requires the activation of the decarbonization process by updating the existing fleet of cars to more environmentally friendly ones, as well as the introduction of measures to control CO_2 emissions.

2.3.2. Analysis of freight turnover of railway transport

Due to summarizing the analytical data of the statistical office of the European Union for the period of 2019-2020, it was found that the freight turnover of railway transport in 2019-2020 decreased by (-5.9%). The most active phase of the decline was observed in the fourth quarter of 2019 (-8.0%). This negative trend continued in the first three quarters of 2020 with a further significant drop, which by the end of the year was (-29%). On the contrary, in the first quarter of 2019 and the last quarter of 2020, growth was recorded compared to the same quarter of the previous year (+2.4% and +5.6%) (Eurostat, 2020).
A negative trend in freight traffic has been established in Greece, Luxembourg and Ireland, whose freight turnover in 2020 amounted to less than 1 billion tonne-kilometers. Montenegro and North Macedonia are also among the countries with the lowest freight turnover (less than half a billion tonne-kilometers). The largest drop in railway freight turnover was found in Latvia (-46.9%), Estonia (-19.8%), Spain (-16.7%), Slovakia (-15.1%) and Luxembourg (-15.0%) (Eurostat, 2020).
Despite the prevailing negative dynamics of freight turnover by rail during the pandemic, a number of European countries registered an increase in 2019-2020. Among these countries are Bulgaria (+28.9%), Greece (+13.1%), Croatia (+12.6%), Hungary (+9.1%) and Ireland (+2.9%), Norway (+5.3%), Montenegro (+0.1%).
Just as before the pandemic, the leaders of freight railway transport in the EU have become Germany (108 billion tkm) 30% of the total EU volume, Poland (50 billion tkm) and France (31 billion tkm). Nevertheless, despite the leadership, the freight turnover of railway transport in Germany during the pandemic also decreased by 4.7 billion tkm.
To sum up, we came to the conclusion that the COVID-19 crisis had the least impact on freight railway transportation than on transportation by other modes of transport, despite the widespread reduction in freight turnover. In addition, from the perspective of sustainable development, this type of transport is the most promising in the transition period of logistics to sustainable development under the influence of COVID-19.

2.3.3. Analysis of freight turnover of maritime (river) transport

As noted in the article earlier, as a result of the pandemic, sea and air freight transportation suffered the most. Against the background of a reduction in the volume of sea freight transportation, 11 of the 12 largest shipping lines were forced to return leased vessels to their owners. In Europe, the main reductions fell on the Danish company Maersk and the international company MSC (headquartered in Switzerland). In total, they abandoned ships with a combined freight capacity of 236 thousand twenty-foot equivalents (UNCTAD, 2020). For the same reasons, the HMM carrier (South Korea) faced an increase in the number of available vessels, having received back previously leased vehicles, which resulted in a general shift in the vectors of traditional logistics chains.
This fact is also confirmed in the report of the United Nations Conference on Trade and Development *Review of Maritime Transport 2020*, which notes that other transport industries feel more confident under the conditions of COVID-19. So, according to experts, under the current conditions, a promising opportunity opens up for the transportation of goods from China to Europe by rail: given the significantly increased time of cargo delivery by sea and the increase in the cost of air freight, many companies may opt for the railway network, which has been significantly less affected by restrictive measures (UNCTAD, 2020).
According to the statistical office of the European Union, in the period from 2019 to 2020, there was a significant decrease in the volume of freight traffic by inland waterways in Europe, which amounted to (-5.7%) for the analyzed period. In general, the dynamics of freight turnover by inland waterways can be characterized as extremely unstable, which makes it difficult to determine the seasonal pattern for the period of 2018-2020 (Eurostat, 2021).

Thus, a sharp decline in freight turnover by river transport began in the second half of 2018, which amounted to -16.6% in the 3rd quarter and -25.3% in the 4th quarter. At the beginning of 2019, there was another decline, which amounted to -2.8%, but in the second half of 2019 there was an increase in freight turnover by +8.0% in the 3rd quarter and +18.9% in the 4th quarter (Eurostat, 2020). The first three quarters of 2020 showed a negative trend (-7.3% in the 1st quarter; -5% - in the 2nd quarter and -8.0% in the third quarter) and only in the fourth quarter there was an increase of +1.8%.

Despite the general trend of reducing freight turnover by inland waterways during the pandemic, there are also those countries that dismantled the increase, among them: Sweden (+59.2%), Croatia (+8.2%), Bulgaria (+6.6%) and Finland (+4.3%).

Similarly, to the *pre-covid period*, Germany and the Netherlands remained the main suppliers of inland water transport in the EU (in tonne-kilometers), whose freight turnover accounted for 70% in 2020. The largest decrease in freight turnover was found in Lithuania (-98.1%), the Czech Republic (-43.5%), France (-12.6%), Poland (-12.1%), Luxembourg (-11.6%), Slovakia (-11.0%). Being the leader among EU inland water transport suppliers, there was also a reduction in freight turnover in Germany, which amounted to (-9.0%) in 2019-2020. A total of 11 European countries recorded a decline in 2020 compared to 2019. Taking into account the fact that the reduction of freight turnover by sea and river transport began even before the COVID-19 pandemic (in 2018), and the situation worsened during the quarantine period, the sustainability of this type of transport is very doubtful.

In addition, from the point of view of the concept of development of future generations, this type of transport is currently the most toxic to the environment, which requires rethinking of not only existing logistics chains, but also engineering and design innovations. To solve these problems, radical changes in the field of engine building and fuel technologies will be required.

2.3.4. Analysis of freight turnover of air transport

The restrictions related to the COVID-19 pandemic certainly affected air freight transportation, the total freight turnover of which in the EU in 2020 decreased by (-9.7%). The most affected were domestic transportation (-14.3%) and transportation outside the EU (-10.9%) (Eurostat, 2020).

In the regional context, a positive trend has been established in five European countries, namely, in Slovakia (+20.7%), Lithuania (+15.2%), Belgium (+13.4%), Malta (+10.1%) and Luxembourg (+10.1%) (Eurostat, 2020).

Among the 20 largest airports in Europe during the COVID-19 pandemic, six showed an increase in total freight turnover, among them: Frankfurt-Hahn (+42.8%), Liege (+26.9%), Maastricht-Aachen (+22.1%) and Leipzig-Halle (+12.2%) (Eurostat, 2020). The negative trend was noted in Munich (-57.0%). In addition, an increase in the number of freight and mail flights was established at 12 airports out of 14. Since in 2020, due to the COVID-19 pandemic, many passenger flights departed without passengers, they were loaded with goods related to COVID-19 (for example, masks, gloves, etc.), which partly explains the growth of freight and mail flights.

Despite the positive dynamics of individual countries and indicators, in general, quarantine measures had a negative impact on the freight turnover of air transport in Europe. Thus, in nine countries, a reduction of more than 20% was established: Czech Republic (-26.9%), Denmark (-25.7%), Spain (-26.4%), Croatia (-29.6%), Italy (-24%), Cyprus (-25.8%), Austria (-27.7%), Poland (-22.2%), Slovakia (-20.7%). The largest drop occurred in Finland (-34.9%), Portugal (-31.5%) and Greece (-30.8%) (Eurostat, 2020).

Based on the presented analysis, we came to the conclusion that the freight turnover of air transport, due to its *not popularity* even before the pandemic, suffered less in comparison with other types of transportation, but this is a fairly short-term trend, which is due to COVID-19 quarantine measures. In addition, as noted earlier, air transportation is still the most expensive mode of transport using fossil fuels, the combustion of which releases CO_2, which does not contribute to the transition of logistics to sustainable development under the influence of COVID-19.

2.4. Freight turnover forecast by means of transport until 2022

Official data (Eurostat) was used as initial information for the forecast, namely: European freight turnover in dynamics over five years (2016-2020) by modes of transport, with the exception of air transportation due to the lack of statistical data. The freight turnover forecast was based on the generalization of homogeneous phenomena (million/tkm and a period of 5 years). To compare the results obtained, average values were used, which made it possible to generalize the characteristics of mass, qualitatively similar transport and logistics phenomena, which made it possible to scientifically predict the main trends.

The presented calculations were carried out in the following interpretations: optimistic, pessimistic and most likely scenarios. In terms of the forecast period (short-term, long-term, medium-term), the authors present a short-term forecast, since the analyzed period was 5 years, respectively, the forecast interval cannot exceed 2.5 years. Taking into account the fact that there are still no data for 2021, the maximum forecast period can only be for 2022. Otherwise, the reliability of the forecast, due to the high degree of uncertainty of the impact of various factors, will be unacceptably small. The forecast results are presented in (Table 4).

Table 4. Results of freight turnover forecast by means of transport for 2022, compiled by the authors according to Eurostat

Indicators	2022	Deviation for 2020/2022	
		Absolute million/tkm	Relative, %
The most likely scenario			
Freight turnover of motor transport	14 530 974,42	1 521 027	11,69
Freight turnover of railway transport	1 489 904,284	-7073	-0,47
Freight turnover of river transport	-34 556 708,98	-	-
Pessimistic scenario			
Freight turnover of motor transport	13 516 655,29	506 708,29	3,89
Freight turnover of railway transport	1 309 173,96	-187 803,04	-12,34
Freight turnover of river transport	-63 843 185,72	-	-
Optimistic scenario			
Freight turnover of motor transport	15545293,55	2 535 346,55	19,49
Freight turnover of railway transport	1670634,60	173 657,6	11,6
Freight turnover of river transport	-5 270 232,23	-	-

Thus, it follows from the presented forecast that in 2022 the most sustainable modes of transport will be road and rail, therefore logistics companies should take this fact into account when developing strategies and development plans. A negative trend will be observed in relation to maritime (river) and air transport. This situation is due to a number of factors that need to be further investigated in order to identify and minimize the most significant logistical risks (for example, seasonality) that were not taken into account in official statistics, which affected the value of the approximation coefficient R^2.

Thus, the key trends in the transition period of logistics to sustainable development under the influence of COVID-19 are the following:

- ✓ increasing the volume of delivery by road and rail due to their greater sustainability;
- ✓ transition of key supply chains to shorter and simpler supply chains;
- ✓ applying more flexible and adaptive management strategies and approaches through the introduction of digital technologies;
- ✓ decarbonization of the logistics industry, including through radical changes in the field of engine building, fuel technologies, optimization of the design parameters for the use of vehicles and the abandonment of fossil fuels in favor of renewable energy sources.

Conclusions

A review analysis of the formation and development of the theoretical and methodological foundations of logistics led to the conclusion that economic, social, cultural, technological and other transformations have led to changes in the vectors of research and interpretation of individual logistics categories. The emergence of the concept of sustainable development contributed to the replenishment of the theoretical basis with new concepts and definitions, in connection with which the authors proposed to understand sustainable logistics as the area of theoretical and applied knowledge about the optimal management of discrete and continuous flows in production, the main purpose of which is to satisfy the needs of all stakeholders of the logistics system while minimizing negative impact on the environment and achieving a stable balance between the environmental, economic and social objectives of the logistics system.

An analysis of the development of transport logistics before the COVID-19 pandemic led to the conclusion that in European countries, with the exception of Ukraine, there was a predominance of motor transport over railway transport. However, this trend tends to change, since there is an increase in freight turnover by rail and a reduction in road transport. In Ukraine, on the contrary, structural changes in freight turnover have been established, characterized by the predominance of railway transport, but its share in the totality of transport logistics operations is declining in favor of motor transport.

A steady downward trend in the freight turnover of river transport has been revealed. The situation is similar with air transportation. However, the reasons for the reduction in freight turnover by these modes of transport are different. The reduction in the turnover of river transport is primarily due to the reduction in maritime freight turnover, which accounts for 90% of the freight turnover in world trade. The popularity of maritime transport is explained by its lowest cost compared to other modes of transport. However, this mode of transport is also the least environmentally friendly, which contradicts the main directions of the concept of sustainable development, and in connection with which the marine community, having imposed stricter rules on environmental requirements, has affected the reduction of maritime transport activity to certain extent. Unlike sea (river), air freight transportation is traditionally less common both in Europe and in the world, due to its high cost.

It was determined that during the COVID-19 pandemic, the transport and logistics system was one of the most affected. Based on the presented analysis, we came to the conclusion that the pandemic not only reduced the turnover of goods by road in Europe, but also contributed to a change in its structure towards an increase in the

turnover of cabotage transportation. It has been established that despite the widespread reduction in the volume of freight traffic, freight railway transportation has suffered to no lesser extent. In addition, from the perspective of sustainable development, this type of transport appeared to be the most promising in the transition period of logistics to sustainable development under the influence of COVID-19.

The COVID-19 pandemic has had the greatest negative impact on maritime and river transport, which allows us to consider this mode of transport as the least sustainable. Despite its *unpopularity*, the freight turnover of air transport, in comparison with other types of transportation, suffered to a lesser extent. However, this is a rather short-term trend, which exists due to the COVID-19 quarantine measures. In addition, as noted earlier, air transportation is still the most expensive mode of transport using fossil fuels, the combustion of which releases CO_2, which does not contribute to the transition of logistics to sustainable development under the influence of COVID-19.

The presented forecast for 2022 indicates that in the near future, the current trend will continue. The most sustainable modes of transport will be motor and railway transport. Therefore, logistics companies should take this fact into account when developing strategies and development plans. A negative trend will be observed in relation to maritime (river) and air transport. This situation is due to a number of factors that need to be further investigated in order to identify and minimize the most significant logistical risks (for example, seasonality) that were not taken into account in official statistics.

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